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AUTHORS

PERSONALS

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Railway Electrical Engineer

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Indexes for 1925

Not all of the readers of the *Railway Electrical Engineer* wish to bind their copies and for this reason only a limited number of yearly indexes have been provided. To all of those who desire indexes for the year 1925, we shall be glad to furnish copies. Requests should be addressed to the circulation department and should be sent in at once.

Belt Slipping In Winter

Among the varied problems of car lighting men, there is one which makes itself particularly manifest as soon as the snow begins to fly and that is the slipping of axle generator belts. There have been many remedies proposed for the correction of this difficulty and some of them seem to work out with a fair degree of success. Probably the reason why the matter has not been carried through to a solution which would be satisfactory to all, is because the trouble does not exist all of the time, but is more or less a seasonable affair, reaching its worst conditions during the winter months.

The fact that the ground is covered with snow, does not necessarily imply that belt slipping will be a constant source of annoyance and a cause of undercharged batteries. However, when the snow is light and the weather is very cold, the movement of the train causes the flying particles to find a lodging place on the axle and generator pulleys. It is only when these conditions have been anticipated and some precautions taken, that the evil of belt slipping can be at least in a measure overcome.

One road which experienced belt slipping trouble has successfully used a form of adhesive compound which it applies to the belt; the results with the use of this material have been highly satisfactory. Another maintenance department, after trying many different ways and means of preventing belt slipping, discovered that the simple application of a roll of friction tape to the generator pulley would furnish sufficient adhesive surface to prevent belt slipping for a limited mileage. It is estimated that a single roll of friction tape will give most satisfactory operating conditions for two or three thousand miles.

Although this means of preventing belt slipping can scarcely be recommended as something which can be applied to all cars, it does have merit, and under certain conditions where batteries are known to be undercharged and cars must be kept in service, it may serve as a simple expedient to keep the equipment in first-class operating condition.

Prospects for 1926

Experience of forecasters in recent years shows that it is unwise to try to foretell what railroad prosperity is going to be over a period of more than five or six months ahead. Certain facts are at hand, however, which indicate what may be expected in the immediate future. The return earned by Class I roads on property investment in the first ten months of last year was at the annual rate of 4.83 per cent. This is a marked improvement since the depression of 1921 and it means a marked improvement in the value of railroad securities and in terms on which railroads can raise new capital.

As a result the railroads have been able to make increased capital expenditures. Owing almost entirely to operating economies that were made possible largely by capital expenditures of the last three years, the net operating income earned by Class I roads in September and October, 1925, was $77,000,000 greater than in the same months of 1923. This increase in net operating income in these two months alone was sufficient to pay almost 9 per cent per annum upon the entire net increase in the property investment of these roads in the year 1923, when the investment made was the greatest of any year since the war.

The foregoing figures show how important it is for the railroads to enjoy sufficient prosperity to make necessary capital expenditures. While they are able to do so, the introduction of electrical machinery and appliances is bound to increase.

A condition of prosperity such as the railroads are now beginning to enjoy, unfortunately is never allowed to endure for a long period of time. In a recent statement, President Markham of the Illinois said: "When conditions are favorable is the very time to be most diligent in keeping them so. . . . Satisfaction is dangerous if it results in a slackening of efforts. We seldom stand still. We are either making progress or slipping back." Now is the time for the electrical departments to launch plans for long needed improvements.

The Great Northern Tunnel Project

The recent announcement that the Great Northern will undertake the construction of a 7¾-mile tunnel through the Cascade mountains, is of interest to electrical men, especially those who are concerned with matters pertaining to electric traction. The present tunnel which cuts through the Cascade mountains, some distance north of the proposed project, has been in operation since 1909, and trains have been drawn through it by electric locomotives; it is only

by means of electric traction that such long tunnels become practicable.

The new tunnel will be nearly three miles longer than the existing one which fact, coupled with a grade of 1.53 per cent, emphasizes unmistakably the tremendous advantage of electric power for all work of this kind. Steam operation through tunnels of such length is almost unthinkable, even with a relatively small volume of traffic. When the Hoosac tunnel on the Boston & Maine, which is 4¾ miles long, was put in operation, steam locomotives were used. There is a slight grade upward in this tunnel from each entrance toward the center. Rail conditions in the tunnel were so bad and the trip took so long, that an engineman could seldom be induced to make the run alone. It must be said their fears were justified, for on many occasions enginemen and trainmen were so overcome by smoke and gas as to require hospital treatment. It was not an uncommon thing for the engineman to hold a broom handle against the tunnel wall to ascertain whether or not the locomotive was moving. Under such circumstances the conditions which would obtain in a tunnel three miles longer may well be imagined.

It is estimated that the cost of the new tunnel on the Great Northern will approximate $10,000,000, but the reduction in the cost of present operation and maintenance will be so great that even this large expenditure will be justified. The outstanding feature of such a project, at least as far as the electrical engineer is concerned, is the opportunity which it will afford to demonstrate the usefulness of the electric locomotive in overcoming what would otherwise be an unsurmountable obstacle to the consummation of such a plan.

Progress of Electric Traction

Motors, generators and electric control equipment are now being applied to two distinctly different types of motive power units. These are the electric locomotive and multiple unit car which receive power from a contact system and the Diesel-electric locomotive or car and the gas-electric car which carry their own power plants. The former are used for heavy trunk line service in congested sections and the latter for switching or light freight and branch line or light passenger service.

Among the important developments of the past year was the inauguration of electric operation on the Virginian on September 21. Two electric locomotives are now used to take a 6,000-ton train up a 2.07 per cent grade, 15 miles long, at a speed of 14 miles an hour. Twenty-thousand horsepower is applied to the train on starting and 12,000 while moving on the grade, a performance which never has and perhaps never will be approached by steam power.

Staten Island lines of the Baltimore & Ohio were placed under electric operation on June 5. A total of ninety 600-volt direct current motor cars and 10 trailers have been placed in service and 21.6 route miles, including approximately 50 miles of track, have been electrified. Automatic substations are used in this installation in connection with a supervisory control system.

On the Detroit, Toledo & Ironton, 17 miles of track have been equipped with a 23,000-volt overhead contact system supported on reinforced concrete arches and one locomotive has been built which is the first of the motor-generator type for commercial use.

The Long Island during the year electrified 28 additional miles of line and has outlined a definite program for further extensions.

The Great Northern is now installing electric traction with motor-generator locomotives on a 24-mile section on the west slope of the Cascade mountains in Washington. The Illinois Central expects to complete its suburban electrification in Chicago by February, 1927. Mercury arc rectifiers will be used in one of the substations.

Seven motor-generator locomotives are now under construction for the New York, New Haven & Hartford and two 600-volt, direct current freight locomotives, seven 100-ton switching locomotives and 29 motor car equipments are now being delivered to the New York Central.

During the year 14 Diesel-electric locomotives were ordered by seven different roads and several of these have been placed in service. The Canadian National is now operating a Diesel-electric articulated car and a single 60-foot Diesel-electric car and has six more of the latter under construction. The engines in these cars weigh only about 15 pounds per horsepower or 51 pounds per horsepower including the generator and the bedplate. Another installation using the same principle is being made by the New York Central in which a 200-hp. Diesel engine will drive a generator supplying power to the motors on a car similar to the present New York Central multiple-unit cars. The gas-electric rail motor car for light traffic requirements was well received by the railroads last year, some 60 cars having been ordered by about 25 different roads.

With regard to further progress it is interesting to note the following statement from L. F. Loree, president of the Delaware & Hudson: "On our main lines of heavier traffic the margin of capacity to take care of additional business is nearing the danger point." While Mr. Loree mentioned specifically improved steam power as a means of meeting traffic requirements and did not refer to electric traction, it is well known that electric power can handle traffic in a manner impossible with steam power.

Electric locomotive tonnage and steam railroad mileage in America have continued to increase at about a constant rate during the past 20 years. High capital charges required for electrification have probably been the greatest deterrent to its adoption in the past. Railroad credit is now improving and according to Mr. Loree there may soon be urgent need for improved means of moving heavy traffic. If the trends of these two conditions continue as they have during the past year, it is only logical to conclude that there will be increased need for heavy trunk line electrification.

The installation of Diesel-electric and gas-electric cars and locomotives is governed by somewhat different factors, which summed up, are essentially improved service with low operating cost. The desirability of the electric drive is shown by its increasing use in rail motor cars and by the fact that many highway buses of this type are now being built.

New Books

Practical D. C. Armature Winding. By L. Wollison. Lond. and N. Y., Isaac Pitman & Sons, 1925. 228 pp., illus., diagrs., tables, 7x5 in., cloth. $2.50.

A practical manual, using only elementary mathematical formulae, and describing methods in detail for all classes of work. Many photographs and unusually clear diagrams illustrate the text.

The Car Lighting Building at Oakland, Cal.

Car Lighting Practice on the Southern Pacific

Maintenance Facilities for the Pacific System Lines Provide for 797 Cars

THE equipment used on the Pacific System Lines of the Southern Pacific was described in the December, 1925, issue of the *Railway Electrical Engineer*. This article deals with the facilities provided for the maintenance of the equipment.

At headquarters in Oakland, Cal., the train lighting department is housed in a two-story brick building 30 ft. wide and 130 ft. long. On the lower floor there is one

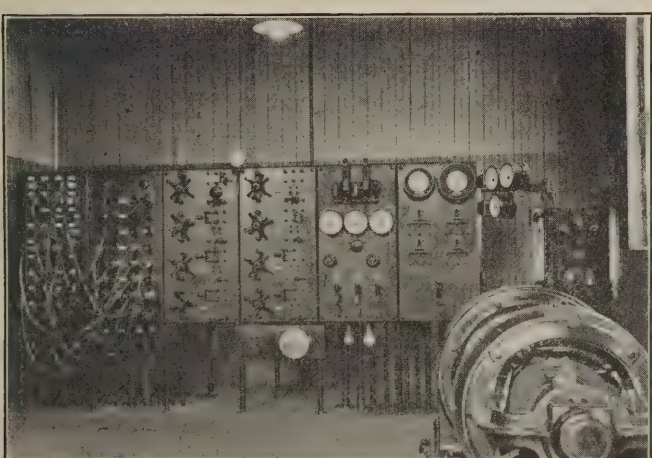


Fig. 1—The Charging Plant

main dividing wall which separates the charging plant from the battery room. The charging plant room is 30 ft. by 25 ft. and the battery room occupies the remainder of the lower floor except for a small room for shower bath and toilet.

All of the upper floor is a repair shop except for an office 30 ft. square and a file room 10 ft. by 15 ft. A built-in office with glass partitions in one corner of the main office is provided for the Train Lighting Engineer.

Charging Plant

Charging current for yard charging and for reconditioning batteries in the shop is generated by a motor-

Fig. 2—Yard Charging Outlets Are Protected by Channel Iron Housings

generator set and a mercury arc rectifier. The motor generator set is a three-machine set and consists of a 75 hp., 440-volt, 3 phase General Electric induction motor driving two, 200 amp. 125 volt G. E. direct current

generators. The two generators can be connected in series to provide 250 volts for series charging when wanted. The mercury arc rectifier is a General Electric, type M.S. rectifier which receives alternating current at 220 volts and delivers 50 amperes direct current at 120 volts. It is used for light loads at night when the capacity of the set is not required.

The switchboard is a six-panel board with a meter bracket at one end. The meter bracket carries two d.c. ammeters and one d.c. voltmeter. The meter circuits are arranged so that these three instruments show voltage and current on any one of the charging circuits.

Fig. 3—The Battery Room

The motor of the charging set is controlled from the right hand panel Fig. 1. The two integrating wattmeters at the top of this panel record a.c. current used. The second panel is used for controlling the two generators of the set. The voltmeter in the center can be used to show voltage on either machine and the two ammeters on opposite sides of the voltmeter show current delivered by each of the two d.c. generators.

Panels 3 and 4 are resistance panels for controlling the current in the charging circuits. There are five rheostats and five double throw switches on each panel. By throwing a switch in one direction or the other, either 125 or 250 volts is put on the charging line which is connected through the corresponding rheostat to the generator panel.

Fig. 4—Battery Tray to Which Protective Coating Has Been Applied by Brush and Flame

The two panels at the left (Fig. 1) are distribution panels equipped with Anderson plugs and receptacles. Ten of the receptacles are connected through the rheostats to the generator panel and by means of the short cables with a plug on each end any one of these 10 power receptacles can be connected to any of the other receptacles. Each one of the balance of the receptacles is connected to a charging circuit in the yard or in the building.

There are 24 charging circuits in the yard and 11 in the shop. The yard lines have an average of four outlets each connected in series and the shop lines each have two outlets also connected in series. Each outlet is ordinarily short circuited by a dummy plug which is removed when a charging cable from a battery is plugged into the receptacle.

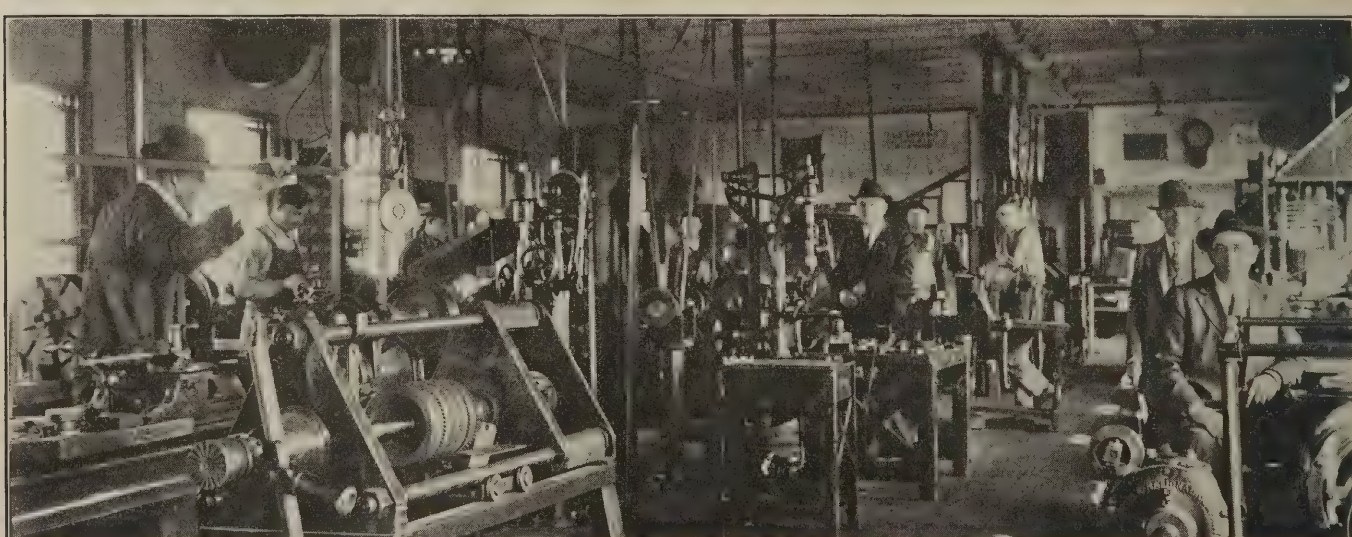


Fig. 5—The Shop

Anderson receptacles are used inside the shop for

charging outlets and Crouse-Hinds CHXD condulets and receptacles are used as charging outlets in the yard. The yard outlets are mounted on the end of vertical pieces of conduit about 5 in. above and at one side of the runway between tracks. They are elevated in this fashion to keep water from getting into the receptacles. Each of the outlets has two receptacles and each outlet is protected by a piece of channel iron, bent and mounted as shown in Fig. 2. A round hole is cut in each end of the

Fig. 6—Yard Telephone Station

protecting channel to allow for inserting the plugs of the charging cables leading to the charging receptacles on the cars.

The underground charging cables in the yard are run in rigid metal conduit. When this conduit was layed, it was placed in open wooden troughs or trunking and supported from the bottom at intervals by small wooden blocks. The trunking was then filled with hot asphaltum

Form 7043 Standard

SOUTHERN PACIFIC COMPANY—Pacific System

Car________ Equipment________ Month of________ 192___

RECORD OF ELECTRICAL INSPECTION

Last "O" Treatment at________ Date________ 192___

DATE	CLASS OF INSPT	STATION	CONDITION			METER	BATTERY		VOLTAGE		* BELT	EXTRA FUSES		INSPECTOR
			GEN	REGULATOR FIELD	REGULATOR LAMP		SP. GR.	FLUSHED	LTS.	BATT.		GEN.	FIELD	
1														
2														
30														
31														

Note * Belt: R—Renewed. S—Shortened or Repaired. O. K.—Good Condition.

Note: O—General Inspection. T—Yard " P—Passing "

Note: At end of month fill out blank at top of new card and send old card to Engineer Train Lighting, S. P. Co., West Oakland, Cal.

Fig. 7—Inspection Card Kept in Car Locker

compound, the top of the trunking put on and the ditch covered over. This installation of underground conduit has now been in service for ten years and has given no trouble except at one low point to which the moisture of condensation drains.

Battery Room

Various types of lead batteries and Edison batteries are used. The battery room shown in Fig. 3 is provided with three benches running lengthwise of the room with aisles between the benches. The benches which are 72 ft. long and 5 ft. wide are mounted on glass insulators and are the same height as the battery trucks. The bench at the left is two tiers high while the other two are single-tier benches. The right hand bench is divided in the center to allow space for sealing, painting and dipping compound kettles. At one end of the center bench as shown in the foreground there are two lead-lined wood tanks. The upper one is a settling tank for old acid and the lower tank contains electrolyte ready for use.

Across each end of the room there are two work benches 5 ft. wide by 20 ft. long and in one corner there is a lead burner bench.

The entire room is served by a crane equipped with

FORM 7011 LOCAL

BATTERY REPAIR RECORD

________ SHOP

CAR NO. ________ APPLIED TO CAR NO. ________

DATE SHOPPED ________ DATE APPLIED ________

BATT. NO. ________ NO. CELLS ________ MANFR. ________ TYPE ________

DATE NEW ________ LAST CLEANED ________ AT ________ POS. NEW ________

HOURS CHARGED ________ CHARGING RATE ________ AMP. DISCHARGE RATE ________ AMP.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Final Voltage Initial Charge																
Sp. Gra. after Initial Charge																
Voltage on Discharge 1st Hour																
2nd Hour																
3rd Hour																
4th Hour																
+ To Cad.																
− To Cad.																
Cell. 5th Hour																
+ To Cad.																
− To Cad.																
Cell 6th Hour																
+ To Cad.																
− To Cad.																
Cell 7th Hour																
+ To Cad.																
− To Cad.																
Cell 8th Hour																
Sp. Gra. at end of Final Charge																
Voltage at end of Final Charge																

READINGS TAKEN BY ________ DATE ________ PILOT CELL TEMP. ________ °F.

To be forwarded to J.J. Hack, Engineer, T.L.H. and V. West Oakland, Cal

Fig. 8—Battery Repair Record Filled Out Each Time Battery Is Overhauled

an air hoist. The crane travels the full length of the room and the hoist can be moved laterally on the bridge of the crane across the room. An ingenious device, developed by the general foreman, takes care of the slack in the air hose as the crane bridge is moved from one end of the room to the other, and makes it practically impossible for the hose to be pulled off accidentally and thereby cause a load on the hoist to be dropped.

Mounted on a high platform in one corner of the battery room is a 400-gal. tank for distilled water. In a small building out in the yard there is a horizontal boiler used for supplying steam to cars in the yard. The boiler is tapped by a copper pipe and led into a water cooled coil. This provides distilled water for keeping the tank in the battery room filled.

Three different compounds are used for sealing and protecting lead batteries. There is a gas heated kettle for the dipping compound used for placing lead linings in trays and another gas heated kettle for melting the cover sealing compound. There is also a third gas burner for heating tray painting compound in a bucket. This compound is painted hot, over the outside of the tray after the battery has been overhauled. After a liberal coating is applied the surface is gone over with a flame. The flame causes the compound to flow into crevices in a manner which could not be duplicated with a brush and when the job is finished, the tray has an attractive glossy surface free from bubbles, holes or bare spots. The protection obtained by this means amply warrants the slight additional effort required to apply the coating.

FORM 2324 LOCAL

DESCRIPTION AND RECORD OF BATTERY (D-10-17-23-200-1F1B-1397-2507)

REQUISITION NO.________ INV NO________ PRICE________

NO.________ TYPE________ SIZE OF PLATE________ "HI+________ W+________ T ASSEMBLED IN________CELL TRAY R'B L D TANKS

NEW IN SERVICE________19____ RATED CAPACITY________AMP HR'S ACTUAL CAPACITY________AMP HR'S

DATE CLEANED	PO'S PLATES		HIGHT SEDIMENT	CONDITION ELEMENTS	CAPACITY TEST	GENERAL REMARKS	DATE	LOCATION			
								APPLIED		REMOVED	
	BKL'D	AV'G HI						CAR	AMP	DATE	CAR

Fig. 9—Card Used to Record History of Each Battery

BATTERY MATERIAL CARD

DATE	TRAY WOOD	LEAD TANKS		RUBBER						ELEMENT		ACID	CONNECTORS				REMARKS
		NEW	REP'D	JARS	SEPT'R	SHEET	COVER	BUSH'G	TUBING	POSITIVE	NEGATIVE		LONG	SHORT	HAND	WIRE	

Fig. 10—Back of Card Shown in Fig. 9

The formulae for the three compounds are as follows:

Painting trays
- 1 lb. paraffine
- 3 lb. rosin
- 5 lb petrolatic cement

Sealing compound for sealing covers and dipping lead linings
- 37 lb. petrolatic cement (Standard Oil product)
- 7 lb. lamp black
- 1 gal. pine tar

Shop

The shop which is on the second floor of the car lighting building is served by a 1-ton elevator located at one corner of the building. The shop is equipped with three lathes a large drill press, a small bench drill with individual motor drive, two grinders, a coil winding machine, a wire reel rack, six armature winding stands, a vice bench with two 5-in. vices, a rack for dipping and draining coils, an electric baking oven with thermostatic control, a lamp dipping stand, an insulation cutting table, two horses equipped with balancing rails for balancing armatures, a belt cutter with mounting for roll of belt, a power supply or test switchboard, a portable stand for testing Sangamo meters, a gas furnace for heating irons and melting solder, a rack large enough to mount 12 regulator panels for testing, and armature press, four 9 ft. armature racks for storing armatures waiting repairs and a four-deck rack placed out in the room for small parts. This rack is 9 ft. long, 3 ft. wide and 5½ ft. high.

There are benches fitted with tool drawers on either side of the room which extend the greater part of the length of the room. There is also a lamp locker and there are three sinks with hot and cold running water at one end of the room.

Except for the bench drill, all of the machines requiring power for operating are driven from a line shaft which is in turn driven by a 10 hp. motor. Some of the special machines and devices used are particularly suitable to the needs of the car lighting and shop electrician and will be described in later issues.

Call System

The coach yard at Oakland is large and it frequently happens that some one in the office or shop wants to get in touch with a man in the yard. For this purpose there are three telephones located at different points in the yard, mounted on charging outlet housings as shown in Fig. 6. There is an air whistle mounted on the roof of the shop and each man is assigned a certain call signal. When his signal is called he goes to the nearest telephone and talks with the man in the shop. There are several places in the building from which the whistle can be blown by pushing a button. The button closes a relay circuit and the whistle valve is operated by an electro-magnet. There is a telephone at each whistle-button station.

When the man in the yard wishes to get in touch with the shop he pushes the button which is on the stand of the yard telephone and this rings a bell in the shop office. This system saves much time and unnecessary walking about looking for some one in the yard.

Records

Essentially four record blanks are used for keeping track of and recording battery and equipment performance.

The record form 7043 shown in Fig. 7 is a card 8½ in. by 11 in. in size. This card is kept in the car locker and it is sent in to headquarters at the end of each month at which time a new card is placed in the locker. The back of the card is left for remarks by the electricians making inspections or repairs.

Each time a battery is overhauled, form 7011, shown in Fig. 8, is filled and also sent to the office. This form is a sheet of paper 8½ in. by 11 in. in size and space is provided on the back for listing material used, credit and remarks.

Form 4470 C. S.

DAILY PERFORMANCE REPORT OF ELECTRIC LIGHTED CARS

STATION________192__

TRAIN No. IN-OUT	NUMBER OR NAME OF CAR	SANGAMO METER	WAS APPARATUS WORKING	DID LIGHTS FAIL	SP. GR. OF BATTERY	HEIGHT OF ACID	VOLTAGE	CHARGED		CONDITION OF					MATERIAL USED	CAUSE OF FAILURE AND REMARKS	LABOR
								HRS.	AMP.	REGULATOR		GENERATOR	Bearings	BELTS			
										LAMP	FIELD						

Fig. 11—Report Sent In to Headquarters Daily From Each Point Where Car Lighting Maintenance Work Is Done

A complete record for each battery is made up from the information on forms 7043 and 7011 and kept on file in the office on a card, form 2324 shown in Fig. 9. This form is a card 5 in. by 8¼ in. in size. The back of this card is shown in Fig. 10.

Form 4470 shown in Fig. 11 is sent in every day from

of gasoline. The upper valve is opened first and then the lower valve is cracked. This allows the blast of air to draw a little gasoline up into the tee and project it in a fine spray against the parts to be cleaned. This removes the dirt almost instantly, taking it out of places which cannot be reached by ordinary methods. As soon as the

TABLE I

Statement of Cost of Operating Axle Lighted Cars
Jan. to Dec., 1922, Incl.

	Sleepers	Diners	Coaches	Postals	Observ.	Buffet	Chair	Total
Total Operating Cost	$42,752.07	$17,179.63	$5,933.12	$2,740.77	$318.86	$1,507.63	$1,024.19	$71,456.27
Number Cars Equipped	218	63	30	12	2	10	6	341
Number Cars Handled	218	63	30	12	2	10	6	341
Average Cost per month per car in service	$16.342	$22.724	$16.480	$19.033	$13.285	$12.563	$14.224	$17.462
Total mileage	21,954,646	5,564,788	2,336,893	657,369	84,610	873,004	352,934	31,819,244
Average miles per car per month	8,392.4	7,360.8	6,491.3	4,530.3	3,525.4	7,275.0	4,901.8	7,775.9
Average cost per 1,000 car miles	$1.947	$3.087	$2.538	$4.201	$3.768	$1.726	$2.901	$2.245

all points where car lighting work is done, to headquarters in Oakland. This form is paper and measures 8½ in. by 17 in. The back is blank.

A fifth form known as 7044 is also kept in the main office, a large number of the forms being bound in a large book or ledger. Form 7044 is exactly like 4470 except that additional columns are added to record battery flushing and lamp renewals.

Costs

An extremely good conception of the factors which govern costs can be obtained from a study of the table of costs shown in Table I which were compiled in 1922.

Forces

For maintaining 797 axle equipped cars on the Western Lines of the Southern Pacific which as before stated include all of the Southern Pacific Lines west of El Paso, the El Paso and Southwestern, and the Arizona Eastern Lines, the maintenance forces are located as follows: Oakland, Cal.; San Francisco, Cal.; Los Angeles, Cal.; El Paso, Texas; Tucson, Ariz.; Phoenix, Ariz.; Globe, Ariz.; Sacramento, Cal.; Sparks, Nev.; Ogden, Utah; Portland, Ore.; Ashland, Ore., and Dunsmuir, Cal.

The work is done under the supervision of J. J. Hack, Engineer Train Lighting, Heating and Ventilation, assisted by H. N. Field, General Foreman, and C. L. Abrams, Electrical Inspector.

Kinks for Car Lighters

SOME particularly useful aids for the car lighting electrician used in the Savannah shops of the Central of Georgia are shown in the accompanying illustrations.

The spray gun shown in Fig. 1 is used to project a fine spray of gasoline in a strong blast of air. This blast or spray will very quickly remove all the grease and dirt from the dirtiest machines that are brought into the shop. It is made of short pieces of ⅜ in. pipe, a tee, a street ell, two couplings, and two ⅜ in. valves. A ¼ in. pipe nipple is placed inside of the upper pipe and soldered in place at the left of the tee so that the right hand end of the ¼ in. nipple projects into the tee ⅛ in. past the center. The connection between the upper and lower pipes at the center is simply a brace welded in place.

The gun is shown in operation for cleaning a generator head in Fig. 2. The upper hose is connected to the shop air line and the end of the lower hose is dipped into a can

dirt is removed the gasoline is shut off and the cleaned part is dried in the air blast. The frame shown back of the operator, Fig. 2, is used to hold armatures while they are cleaned by the same method. The gun is also used

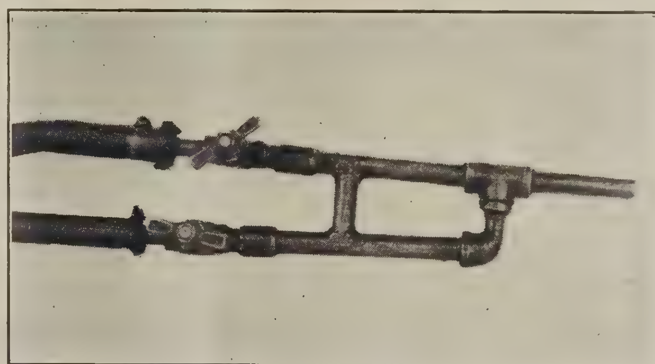


Fig. 1 Spray Gun Used for Cleaning Dirty Machinery

for painting show motor frames and other machinery parts which are difficult to paint with a brush.

Two ideas are shown in Fig. 3. The socket wrench in the center is a standard Edison battery wrench. The

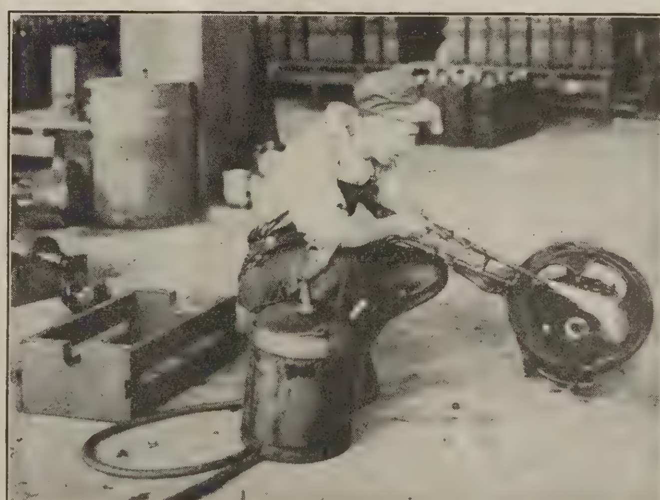


Fig. 2 The Cleaning Gun in Use on a Generator Head

device at the left is an Edison battery terminal puller to which a special link has been added. Occasionally a terminal which has become corroded, comes off so hard that the jaws of this puller will spread and slip off, with-

out loosening the terminal. The link is just large enough to slip down over the outside of the jaws and prevent their spreading.

The wrench and the puller have to be used alternately when terminals are being removed from batteries with

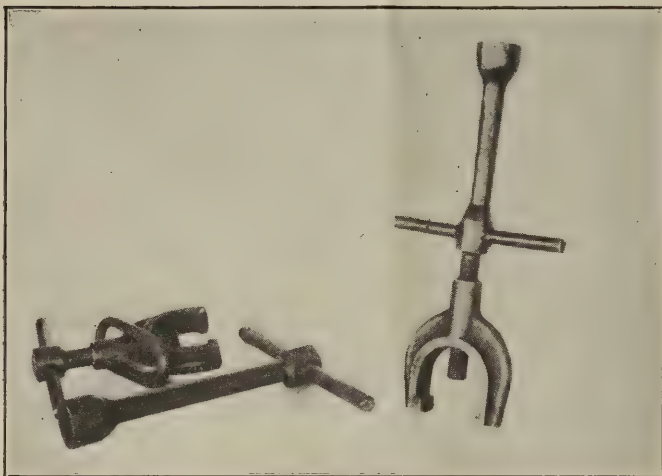


Fig. 3 An Edison Terminal Puller with Compression Link, an Edison Battery Wrench and a Combination Wrench and Puller

the result that the particular tool wanted is misplaced or is out of reach when wanted. To obviate this difficulty a combination tool shown at the right, Fig. 3, has been made by cutting off the handle of the wrench and welding the wrench shank to the screw head of the puller.

Almost every shop has its armature stand and they are

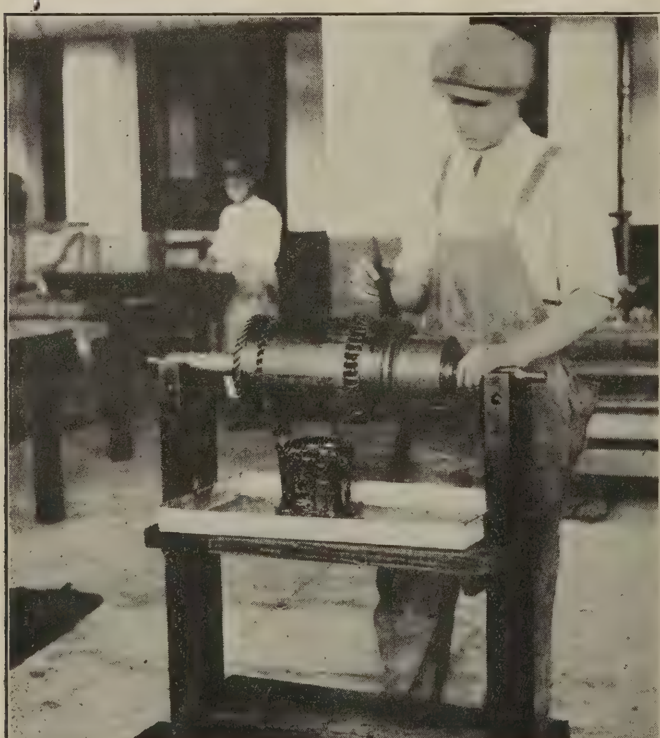


Fig. 4 Armature Stand for Cleaning, Painting, Banding and Undercutting

practically all different in detail of construction. The stand shown in Fig. 4 is a particularly good one. It is 38 in. high to the center of the armature shaft and the uprights are 28 in. apart. It is mounted on casters having 2½ in. iron wheels. These casters are used in the shop for making dollies and were obtained from the storeroom. Each pair of casters is fitted to a 3 in. x 4 in. piece of timber 20 in. long. The lower platform is made of 1 in. material and is 32 in. long by 20 in. wide. The shelf is also made of 1 in. material and measures 14 in. by 30 in. The uprights are made of 2 in. by 6 in. stock. They are notched at the top and a 5-16 in. bolt is put through each upright, 2 in. from the top to prevent splitting. The pan is made of heavy galvanized iron just large enough to fit the shelf.

The stand is used for cleaning, painting, undercutting, banding and for moving armatures around the shop. When the stand is used for banding armatures, the reel of banding wire is mounted near the stand so that it is free to turn, and tension on the wire is obtained by passing the wire between two fibre blocks bolted to the shelf of the stand. The armature is turned by a crank which screws onto the threaded end of the armature shaft.

W. A. Hancock, electrical foreman, is responsible for the compression link on the Edison puller; the combination tool was devised by T. A. Simmons, and the gun and armature stand were built by J. G. Prestwood. T. A. Simmons is shown operating the cleaning gun. The man painting the armature, Fig. 4, is J. T. Landsberg, a co-operative student of the Georgia School of Technology. The co-operative course is so arranged that the student has class room work for one month and work in some shop for one month, this alternation of activities continuing throughout the entire five years of the course.

Gas Electric Lift Bridge

An interesting application of gas-electric drive will be made by the Pennsylvania Railroad to operate a vertical lift bridge across the Chesapeake and Delaware Canal, now being installed south of Philadelphia. Previously this railroad bridge was a stationary structure but, due to the widening and deepening of the canal and the consequent passage of large boats through it, a bridge of the lift type is necessary.

As the bridge is remote from electric power lines, gas-electric drive was decided on as being the cheapest method of operation. Complete electrical equipment will be furnished by the General Electric Company for this purpose.

Two sets of 100-kilowatt gas-engine driven generators and exciters will be installed in the operator's house on the shore, together with a switchboard and necessary control devices. Two 100-horsepower motors to operate the bridge will be located in the machinery house on the bridge itself. Flexible cables will connect the motors to the shore power supply.

To open or close the bridge, the gas engine will be started first, as the intervals between operation will be too long to keep the engine running continuously. By means of a selector switch the operator will next select the combination of generator and exciter he will use. The third operation, utilizing manual control, starts the motors, putting the bridge into motion. At the nearly-open or nearly-shut position, a limit switch will shut off the power and, to complete the motion, the limit switch will be short circuited by a push button and the bridge jogged along to the fully-closed or fully-open position.

Notes on Recent Car Lighting Tests

A Comparison With Results of a Decade Ago Shows Remarkable Increase in Efficiency of Lighting Units

By R. W. Cost
Illumination Bureau, Westinghouse Lamp Company

THE importance of adequate and efficient artificial illumination in railway coaches prompted the Association of Railway Electrical Engineers to conduct a rather extensive research in day coach lighting during the summer of 1913, when over one hundred car lighting tests were made, covering a period of approximately three months. These tests were conducted in a standard day coach at the Collinwood Shops of the L. S. & M. S. Railroad, Cleveland, and were supervised by a number of prominent illuminating engineers cooperating with the Association's Committee on Illumination.

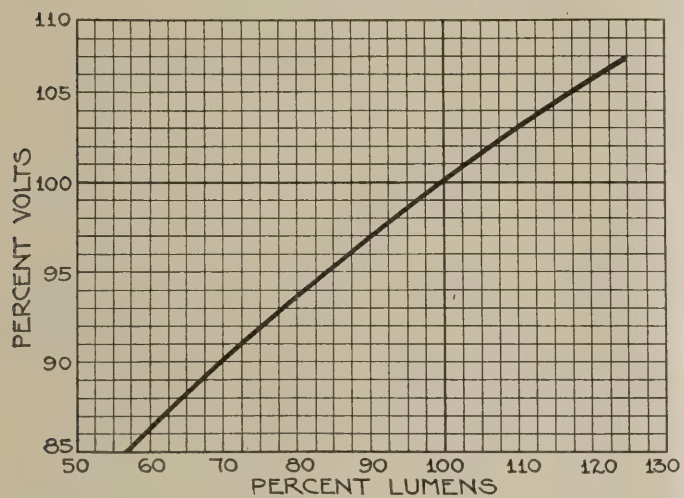


Fig. 1—Curve Showing Relation Between Volts and Lumens With Mazda C Lamps

Quite a variety of opal and glass reflectors including direct, semi-indirect and indirect units were submitted by manufacturers for the tests in which either vacuum type Mazda lamps or Pintsch gas served as the illuminant. In some tests the units were mounted on the center deck, in others on the side deck, and spaced at two, three and four seat intervals. Several different mounting heights for luminaires suspended from the center deck were used and the headlining finish of olive green was changed to a flat white for those tests in which a considerable portion of the light reached this surface.

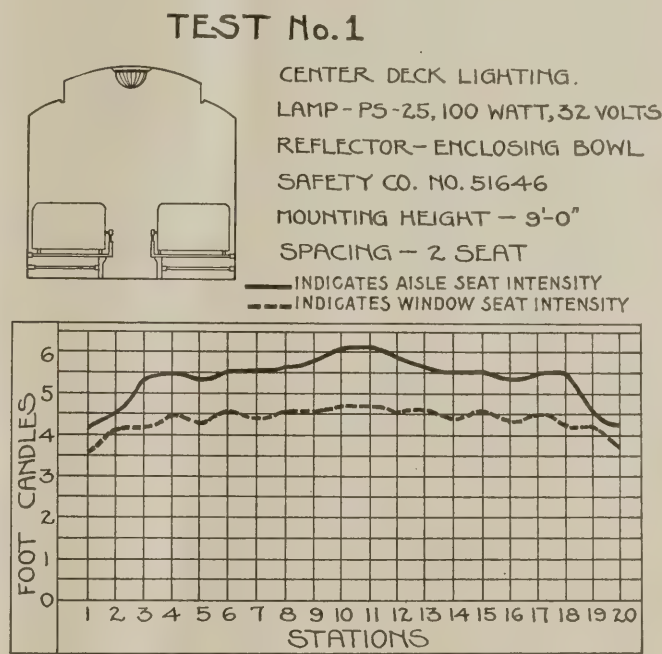


Fig. 3—Illumination Curve—45 Degree Reading Plane

Although the intensities obtained on the normal reading plane were of primary interest, the factors of efficiency, economy, diffusion and glare were considered quite important in the matter of judging the merits of each installation tested.

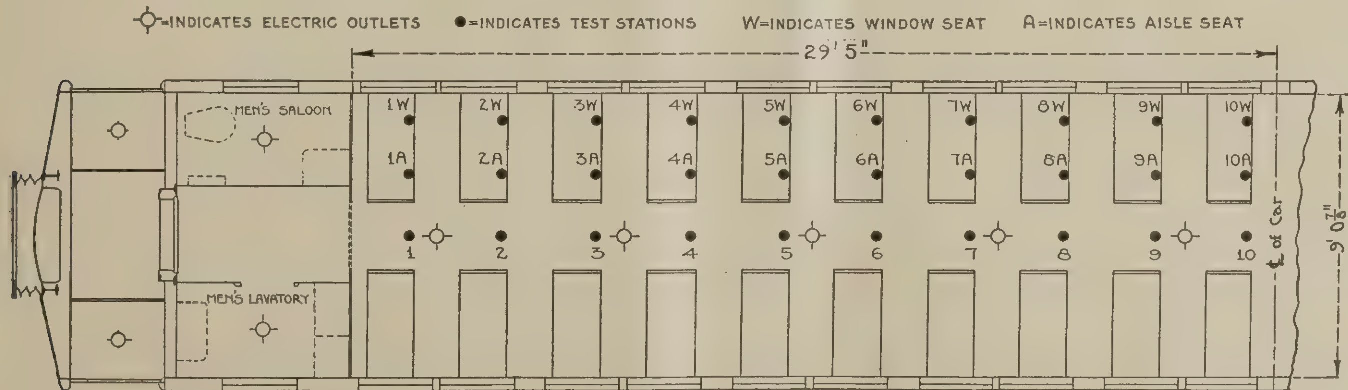


Fig. 2—Center Deck Lighting—Two Seat Spacing

At the conclusion of these tests, a digest of the data obtained was published by the Association of Railway Electrical Engineers under the title of "Day Coach Lighting." It contains quite comprehensive recommenda-

tions on lighting this type of car together with detailed test data on a number of the more important tests.

The tests demonstrated that equally good illumination, efficiency, distribution and uniformity, can be obtained with the luminaires mounted either on the center deck or on the side decks. Center deck lighting, however, requires fewer units and less maintenance and gives less trouble from shadows cast by the passenger's head on his own or another passenger's reading. In the suburban car where the aisle is at times occupied with people standing, side deck lighting will give more satisfactory illumination for reading as the standing passengers will not cause objectionable shadows on the reading matter of those seated. This type of lighting is also advantageous where advertisements are displayed in suburban cars. With direct lighting systems two seat spacing, approximately six feet, should not be exceeded or uneven distribution of illumination will result. This does not apply to indirect or semi-indirect lighting where satisfactory distribution may be obtained with three seat spacing. The use of a light colored head lining secures the greatest possible efficiency in the utilization of natural and artificial light and produces a more cheerful effect in the car than where a dark color is used.

During the past year the Committee on Illumination of the A. R. E. E. has undertaken to compile with the assistance of Mazda lamp manufacturers, data for its proposed manual of "Lighting Practice for Railroads." It is intended that the manual shall contain practical information applicable in laying out modern lighting plans for railway properties, and serve as a handy reference to the engineer or electrician in planning new or improved systems.

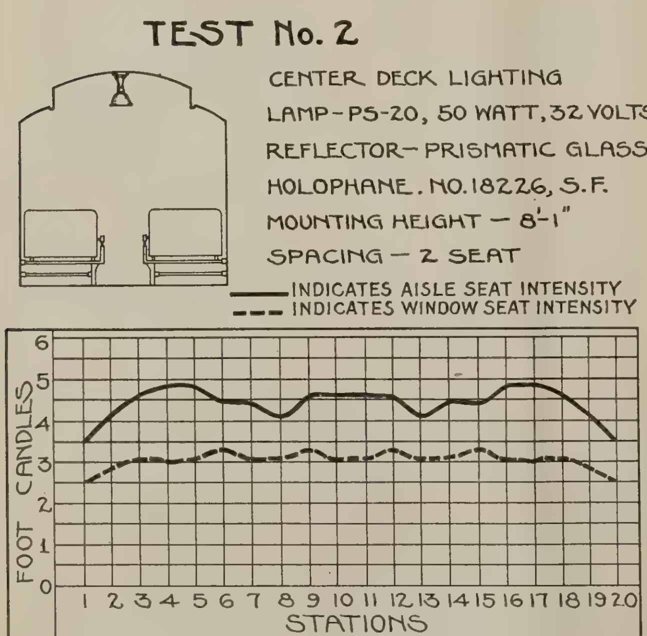


Fig. 4—Illumination Curve—45 Degree Reading Plane

The subject of Day Coach Lighting required special investigation due to the fact that modern Mazda lamps have different characteristics from those used in 1913. Table No. I shows a comparison of the lumen output of the principal train lighting lamps used in 1913 and 1925, including the light center lengths of the 50 and 100 watt lamps:

TABLE No. 1

CAR LIGHTING LAMPS

Watts	Type	Bulb	Light-Center Length	Initial Rated Lumens
		YEAR 1913		
15	B	G-18½	...	127
25	B	G-18½	...	175
50	B	G-30	4"	430
100	B	G-30	4 1/16"	900
		YEAR 1925		
15	B	G-18½	...	141
15	B	S-17	...	155
15	C	PS-16	...	151
25	B	G-18½	...	243
25	B	S-17	...	273
25	C	PS-16	...	310
50	C	PS-20	3¾"	705
75	C	PS-22	4 5/16"	1,215
100	C	PS-25	5 8/16"	1,690

From this table it may be seen that the lumen values have been substantially increased and that light center

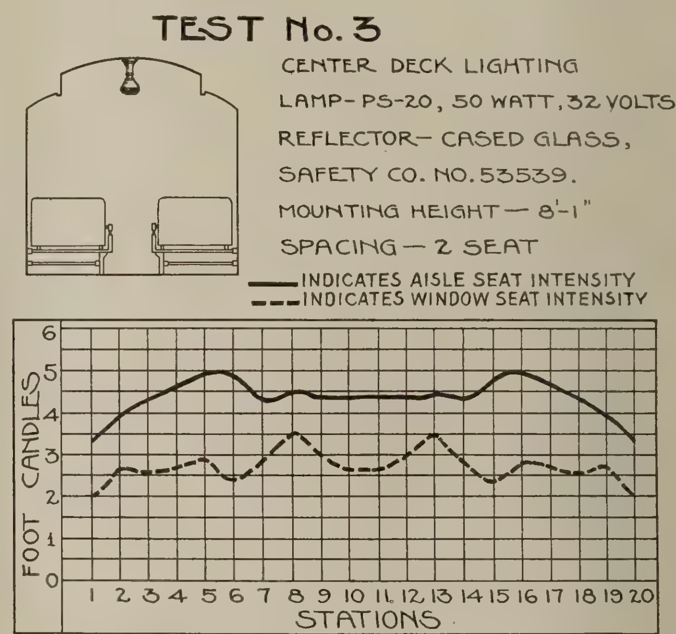


Fig. 5—Illumination Curve—45 Degree Reading Plane

lengths have been altered. This change in the light center length obviously requires either a correction of the lamp position or the use of a properly designed reflector. The "light-center length" is the distance from the center of the filament to the end contact point of the screw base. The "lamp position" is the distance between the plane of the reflector fitter set screws and the contact point on the base of the lamp.

The 1925 Tests

In June, 1925, four tests were made for the Committee on Illumination of the A. R. E. E. in two standard 70-foot coaches, each car having an 80-passenger capacity. The decks were finished in a dark cream color with a reflection factor of 65 per cent and the seats were dark olive green plush. The lighting units were spaced at 2-seat intervals and mounted on the center deck in all tests. As data from the 1913 car lighting tests showed that equally satisfactory illumination results from either half deck or center deck arrangement of units, the latter system was chosen for the tests because of its predominance in modern coach lighting.

All lamps had been rated for lumen output before these

tests. The open bottom reflectors used in tests Nos. 2, 3. and 4 were designed for a 2¼" fitter and a 1⅛" lamp position and each lamp was purposely used in the same position during the three tests.

The lamps employed were designed for 32-volt operation. As the potential at the lamp sockets was slightly below this value, the photometer readings were corrected to show the intensities which would result using rated voltage. The correction factor may be obtained from the "Volts-vs.-Lumens" curve shown in Fig. 1. For example, if 32-volt lamps are operating at 30 volts, or 93.7 per cent normal potential, the resulting illumination intensity will be only 80 per cent of normal.

The tests were conducted and results computed according to the procedure in the Day Coach Lighting Tests of 1913 in order that some comparable data might be obtained. Photometric readings were taken at only thirty test stations facing to rear and thirty stations facing to front of car, covering one-fourth of the seating space in the coach, as previous tests have shown that this method will give representative results for the entire car. Fig. 2 shows location of test stations for obtaining intensities on the 45 degree and horizontal planes, seats facing to rear.

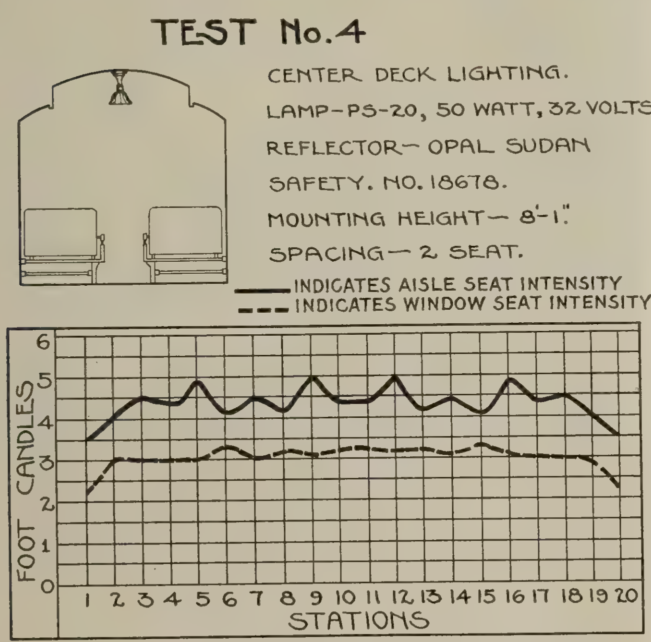


Fig. 6—Illumination Curve—45 Degree Reading Plane

Enclosing hemispheres equipped with porcelain enameled reflectors recessed in the center deck, using 100-watt clear bulb PS-25 Mazda C lamps, were employed in test No. 1. These hemisphere bowls had previously been measured for efficiency, or total light output. Fig. 3 shows the illumination intensities on the normal reading plane of the aisle and window seats throughout the car in this test.

Tests Nos. 2, 3, and 4 were conducted with open bottom reflectors suspended from the center deck. The 50-watt PS-20 inside frosted bulb Mazda C lamp was used.

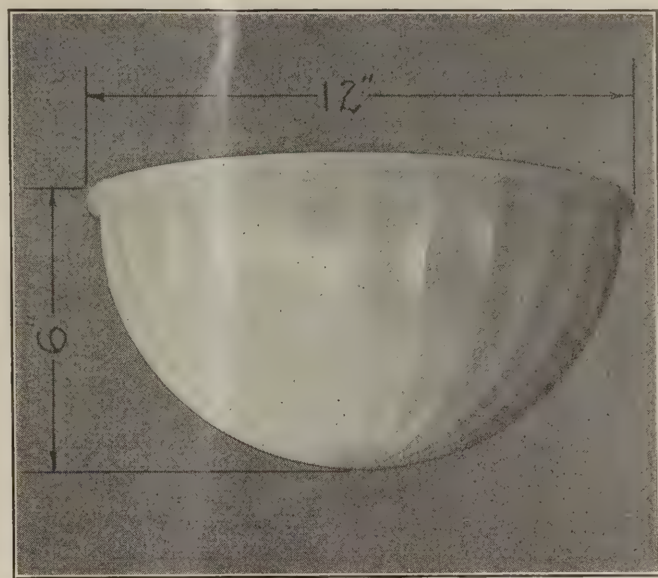


Fig. 7A—Moonstone Enclosing Bowl

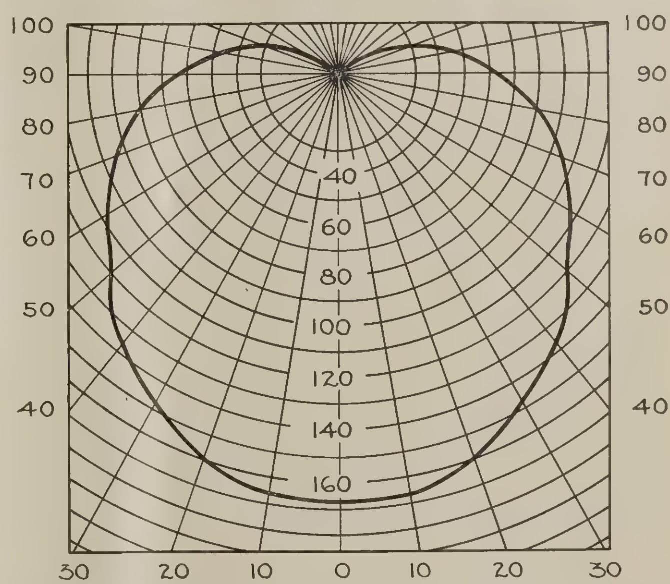


Fig. 7B—Distribution Curve for Enclosing Bowl Reflector, Using 100-Watt, 32-Volt, PS-25 Clear Lamp. (Test No. 1)

This type of lamp does not appear on standard schedules at present, but the Committee felt that they preferred tests on the inside frosted lamps. Figs. 4, 5 and 6 show the illumination intensities on the normal reading plane

Table No. 2

			Average Foot-Candles					
			45° Reading Plane			Horizontal Plane		
Test No.	Reflector	Size Lamp Watts	Window Seat	Aisle Seat	Mean on Seats	Mean on Seats	Aisle Only	Entire Car
1	Enclosing Bowl	100	4.35	5.30	4.83	5.96	8.55	6.48
2	Prismatic	50	3.06	4.40	3.73	4.18	6.18	4.58
3	Cased Glass	50	2.72	4.26	3.49	3.71	6.00	4.16
4	Opal	50	2.97	4.28	3.63	4.06	5.72	4.38

of the aisle and window seats of tests Nos. 2, 3 and 4, respectively, and are based on the outputs of 1,690 lumens for the 100-watt lamp and 705 lumens for the 50-watt lamp.

Figs. 7, 8, 9 and 10 are illustrations of the reflector glassware used in these tests together with their corresponding light distribution curves.

Table No. 2 shows comparative illumination intensities obtained on the 45 degree reading plane and horizontal plane in the four tests.

Table No. 3 shows a comparison of "lumens generated per running foot of car" and "average foot-candles on the 45 degree plane" for two open types of reflectors obtained in the 1913 and 1925 car lighting tests. The luminaires were spaced at two seat intervals and mounted 8 ft.-1 in. above the car door in all instances. It is interesting to note that improvements in Mazda lamps alone

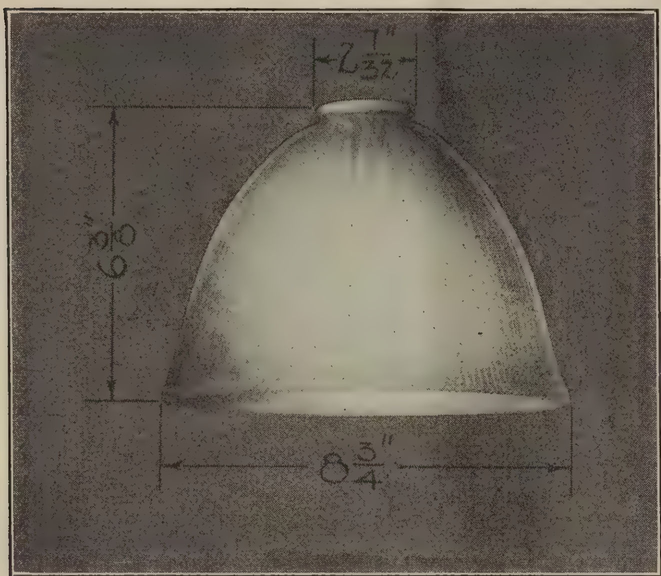


Fig. 8A—Prismatic Reflector No. 18,226, S. F.

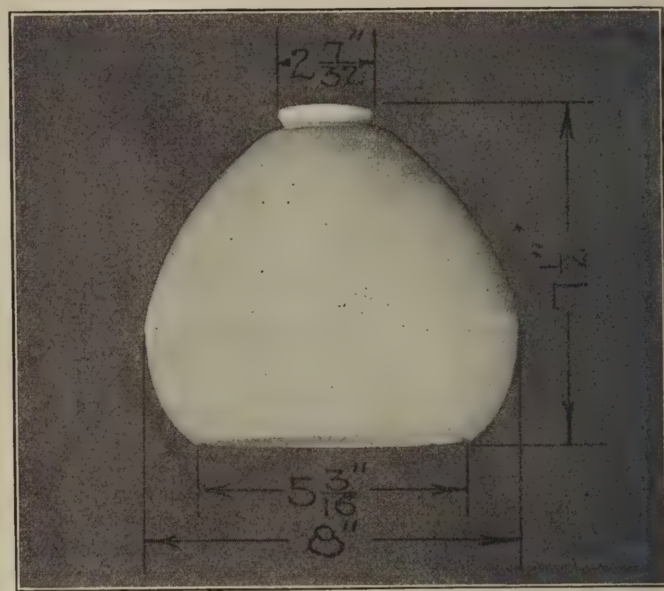


Fig. 9A—White Cased Glass Reflector

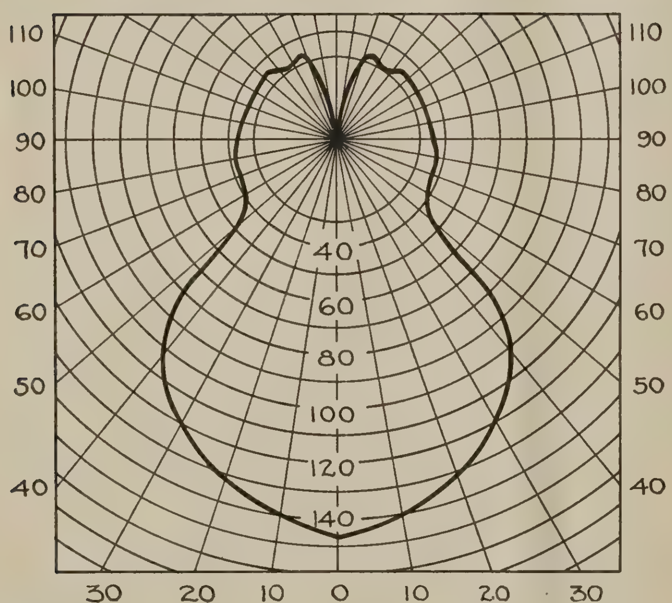


Fig. 8B—Distribution Curve for Holophane Reflector, No. 18,226 S. F., Using 50-Watt, 32-Volt, PS-20, Inside Frost Lamp. (Test No. 2.)

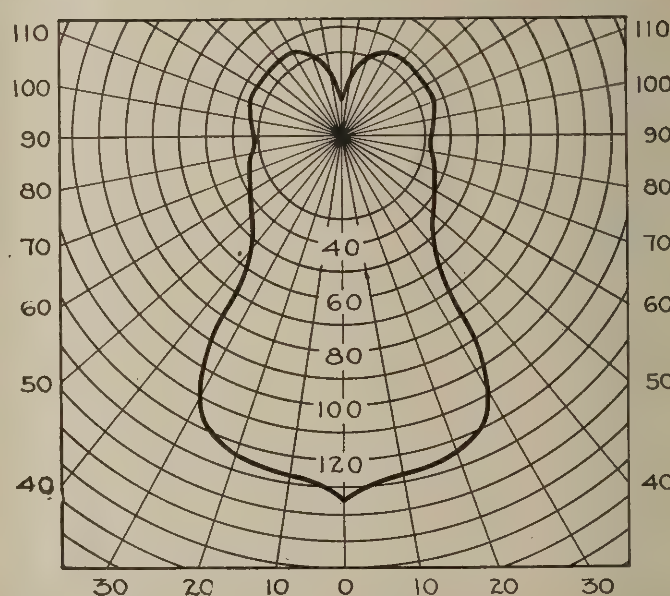


Fig. 9B—Distribution Curve for Cased Glass Reflector, No. 53,539, Using 50-Watt, 32-Volt, PS-20, Inside Frost Lamp. (Test No. 3.)

Table No. 3

Type Reflector	Size Lamp Watts	Lumens per running foot of car: Year 1913	Year 1925	Aver. Foot-Candles on 45° Plane, Year—1913: Aisle Seat	Window Seat	Aver. Seat	Year—1925: Aisle Seat	Window Seat	Aver. Seat
Open Prismatic	50	66⅔	117½	1.94	1.50	1.72	4.4	3.06	3.73
Glass Open Opal	50	66⅔	117½	2.00	1.65	1.83	4.28	2.97	3.63

are responsible for the higher illumination intensities now prevailing. The capacity of the battery and generating system in some cars has been increased during the past twelve years but in most instances this became necessary due to the intallation of electric fans or other appliances.

For satisfactory illumination in a day coach, an illumination intensity of 3 to 6 foot-candles should be provided when measured on a 45 degree plane 33 inches above the car floor at the seats, which position is accepted as the normal reading plane. This recommended intensity is equivalent to an average horizontal illumination of 4 to 8 foot-candles. An intensity of 3 foot-candles on the 45 degree plane should be considered a minimum under which comfortable reading of fine print, such as newspapers, may be done because a higher intensity is required to bring out details of objects in motion than is necessary on stationary objects. Even 3 foot-candles is not to be considered an *adequate* intensity, particularly in view of the fact that to secure this illumination there need be expended only about one-half the wattage that was necessary some ten years ago.

From a consideration of the above data, it will be noticed that with a good design of reflecting or diffusing glassware, the useful illumination on the reading page may now be almost exactly double what it was in 1913. Yet with such a remarkable increase, the power consumption still remains on the same basis, namely one 50-watt lamp at two-seat spacing.

Another interesting conclusion is evident, namely that the open reflector for center deck lighting will produce approximately 50 per cent more illumination on the reading page than is feasible from an enclosing hemisphere. This ratio holds true for either horizontal or 45 degree plane illumination. Some improvements can be hoped for through the medium of more efficient reflectors to back up the ceiling hemispheres, but nevertheless such units will always entail a considerable loss and their employment becomes justified largely upon the basis of reduced glare, more sturdy construction, and perhaps a slight reduction in the necessary maintenance.

Certainly such tests as these are illustrative of the advancement in coach lighting practice and the results speak well for the progressive railway companies and car builders who are thus seeking by all possible means to give more comfort and more security to the riding public.

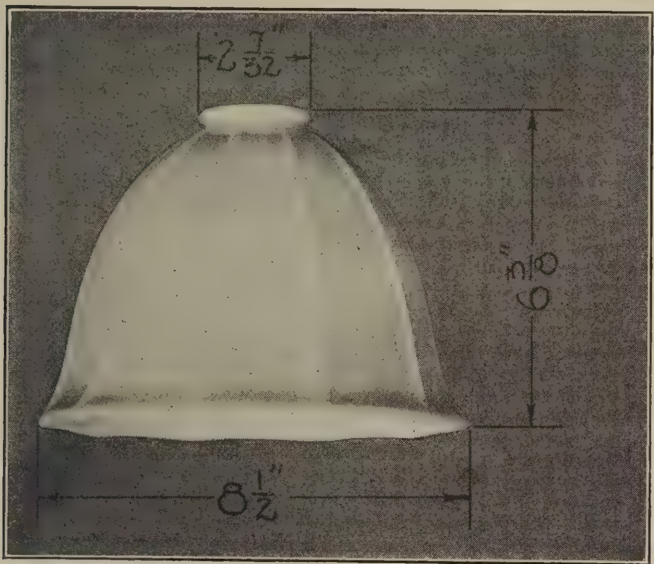


Fig. 10A—Sudan Opal Reflector

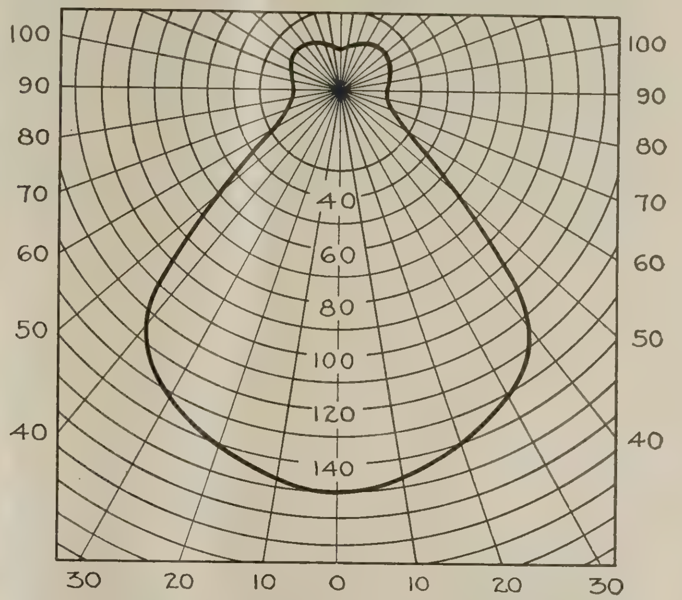


Fig. 10B—Distribution Curve for Sudan Opal Reflector, Using 50-Watt, 32-Volt, PS-20, Inside Frost Lamp. (Test No. 4.)

At a Station on the Lotschberg Line

Arrangement of Supporting Structure on Four-Track Section

Bolting Together the Two Halves of an Arch

View of Catenary on Curve from Top of Construction Car

Train Used by Wiring Crew—Guard Railings on Platforms Are Down to Clear Contact Wire Upon Entering

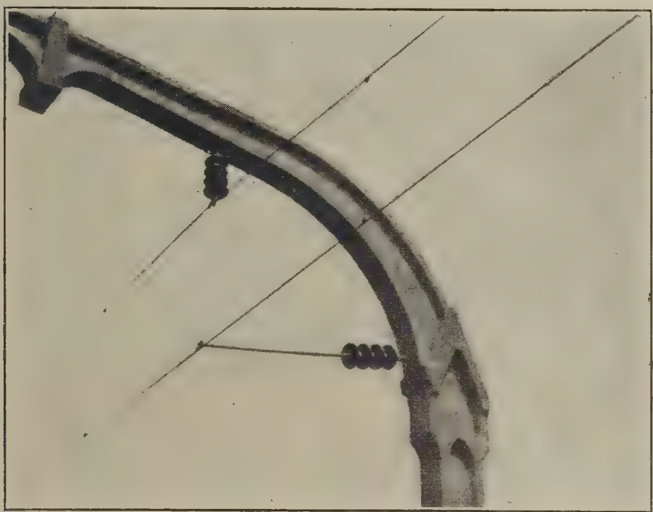
Overhead Contact System on the D. T. & I.

Reinforced Concrete Arches Are Used to Support a 23,000 Volt Non-Ferrous Simple Catenary

OVERHEAD construction for the electrification of the Detroit, Toledo & Ironton has now been placed on the 17 miles of line from Fordson, Mich., to Flat Rock, Mich. The supporting structure is unique in design and consists essentially of precast reinforced concrete members, bolted together and supported on concrete foundations.

Catenary Supporting Structure

On double track line the supporting structure consists of two columns and two half-arches. Arches which span three or more tracks are lengthened by the addition of a filler member placed between the two half-arches.



Type of Catenary Used on Tangent Track

Reinforcing steel in the members is arc welded to special castings used at the ends of the members and the concrete is tamped after it is placed in the molds. After setting for 24 hours the members are placed in steam at a temperature of from 90 to 130 degrees for another 24 hours and then placed in drying ovens at the same temperature for a similar period. From the drying ovens the units are seasoned in storage racks for 18 days before they are set up. Each half-arch contains one cubic yard of concrete and weighs 4,150 lb. Each column averages 2½ cubic yards of concrete and weighs 11,167 lb.

Pits for the foundations are dug 10 ft. long by 8 ft. wide and 8 ft. deep. Forms are placed in these pits. When the forms are filled they contain about 3.8 cubic yards of concrete and weigh approximately 15,000 lb. each. Thus a completed trolley arch, including two half-arches, two columns, two small caps and two foundation posts, totals about 60,650 lb.

Wherever there is contact between metals, as at the points where half-arches and columns are joined by bolting together the bare steel end plates, a coating of tar pitch is first applied to exclude moisture and consequent corrosion. Grout is employed to fill the 2-in. spaces left at the trolley tower bases and is also applied over all other joints, concealing the bolts and nuts and making completely covered concrete structures.

Grounding

The steel in each arch is grounded by a 1½-in. galvanized iron pipe which is driven down 8 ft. below the bottom of the foundation pit. A bronze cable with a terminal on each end is used to connect the pipe with one of the six 2-in. anchor bolts, 36 in. in length which are used to secure the column to the foundation.

The contact wire is a 4/0 bronze wire supported by a simple catenary. The catenary or messenger is ½-in. seven-strand bronze wire. The supporting arches are spaced 300 ft. apart and the messenger wire is supported from the arches by porcelain insulators having a dry flashover voltage of 320,000 volts. The insulators are fastened to yokes built into the arches. The contact wire is hung from the messenger by bronze hangers spaced 15 ft. apart. When the wiring is strung the messenger is given a tension of about 3,000 lb. and the contact wire a tension of 2,000 lb. by means of a dynamometer.

Double Track Arch Being Raised to Position on Top of Columns

On tangent track insulated steady braces mounted on the side of the arches and secured to the contact wire keep it from swinging. On curves inclined hangers are used to support the contact wire and the insulators which hold the messenger are offset toward the inner side of the curve and hung from special castings. The castings are provided with a number of holes which allow the insulator to be adjusted to exactly the correct position.

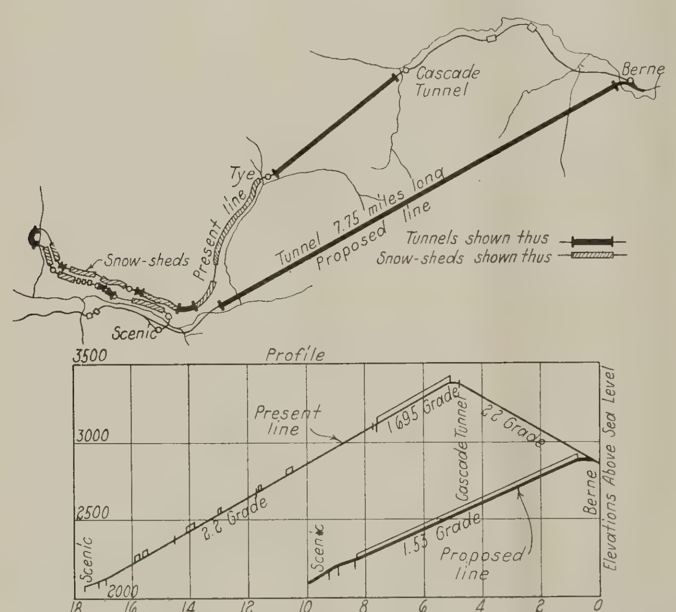
The three-wire feeder system of power supply will be

used. The feeder wire will consist of ½-in. stranded copper mounted on pin type insulators located on the center of each arch. This feeder is connected to the contact wire through auto transformers in such a way that the difference of potential between the feeder and contact wire is 46,000 volts and the contact wire potential to ground is 23,000 volts. This method of feeding energy to a train minimizes inductive interference by causing current to come to the train from opposite directions. This effect is still further aided by the extremely high voltage and correspondingly low values of current used.

With this system of feeders the running rails are a grounded neutral connection to the auto transformers. The rails are bonded with short "L" head copper bonds.

Great Northern Begins Work on Long Tunnel

The Great Northern has awarded a contract to A. Guthrie & Co., Inc., St. Paul, Minn., within the last few weeks for the construction of a change in its main line through the Cascade mountains, approximately 100 miles east of Seattle, that involves the driving of a tunnel 7.75 miles long—the longest railway tunnel in America. The present line which was built in 1892 crosses the divide



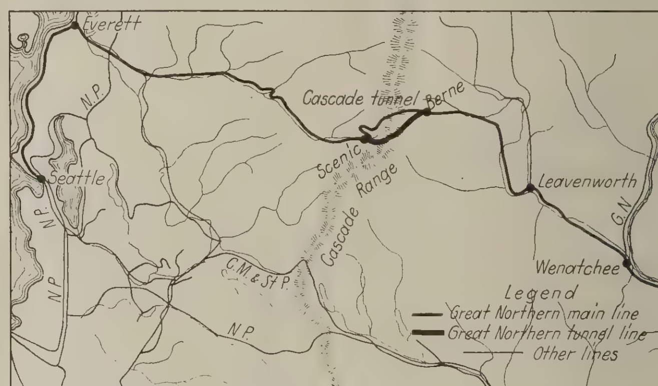
Location Map and Profile at the Site of the Cascade Crossing

at an elevation of 3,385 ft. above sea level. It has sharp grades and curves, numerous snow sheds and several tunnels, the longest of which is 13,873 ft. in length. On account of the heavy snowfall, which reaches a maximum in a single season of 410 in. at Berne and 670 in. at Cascade tunnel, it is difficult and expensive to keep the line open for operation and many studies have been made in an effort to secure a new location with a lower crossing that would avoid the snow trouble. The increasing importance of a thoroughly dependable line, the fact that additional sheds were needed to keep the present line open, and the heavy repairs required annually on existing sheds and tunnels, brought expenditures to the point where a new line would show a substantial saving.

The new line as located will shorten the distance more than 7½ miles, eliminate nearly six complete circles of curvature and will escape most of the severe snow trouble. It involves the construction of a single track tunnel, 16 ft. wide, 22 ft. above the top of rail and 7.75 miles long, which is estimated to cost $10,000,000. A comparison of the principal characteristics of the present and proposed line is as follows:

	Present Line	Proposed Line	Difference
Length	17.68 miles	10.01 miles	7.67 miles
Maximum curve	10 deg. .00 min.	5 deg. .00 min.	5 deg. .00 min.
Total curvature	2,169 deg.	219 deg.	1,950 deg.
Maximum grade	2.2 per cent	2.2 per cent	0 per cent
Tunnel grade	1.695 per cent	1.53 per cent	0.165 per cent
Summit elevation	3,385 ft.	2,879 ft.	506 ft.
Total rise westward	532 ft.	26 ft.	506 ft.
Total fall westward	1,299 ft.	793 ft.	506 ft.
Snowsheds, total length	6.04 miles	0.00 miles	6.04 miles
Bridges, total length	0.23 miles	0.04 miles	0.19 miles
Tunnels	3.66 miles	7.75 miles	4.09 miles

While the plan to be followed in the construction of this tunnel will depend largely upon the character of the ma-



Location of the Great Northern's Crossing of the Cascades

terial encountered, reliable information concerning which is not available it is the present intention to carry on construction operations at three points, from the portals at each end and from a shaft to be sunk near the point where a creek crosses the line of the tunnel about two miles west of the east portal. The pioneer tunnel, in conjunction with a center heading, will be driven between the shaft and the west portal, but it is probable that the center heading method alone will be employed between the shaft and the east portal.

This work will be carried out under the direction of J. R. W. Davis, chief engineer of the Great Northern, St. Paul, Minn., with Colonel F. Mears, assistant chief engineer at Seattle, in direct charge.

A 250 hp. Diesel with Lentz Drive

Canadian National Articulated Diesel-Electric Motor Rail Car

Diesel-Electric Cars for the Canadian National

Articulated Construction on Two Cars with a Seating Capacity of 126—Three-Passenger Seats Used

THE Canadian National has developed and recently placed in service the first of an order of nine Diesel-electric cars which are being built at its Point St. Charles shops, Montreal, Quebec. Seven of the nine units are single cars having an overall length of 60 ft. and the remaining two are of the articulated type with an overall length of 102 ft.

The two types of cars contain many similar features of design and construction. The bodies of both the 60-ft. and the articulated cars were built by the Ottawa Car Manufacturing Company and are of steel construction throughout. The interiors are finished in mahogany and have a 5/16-in. Agasote ceiling painted in cream color. Double floors are applied throughout with the exception of the engine rooms where a single floor 1¼ in. thick, covered with checkered aluminum floor plates, is used.

Electric lighting is provided from 30-volt storage batteries. Aluminum conduits for carrying the lighting circuits, power and control circuits are used throughout. Ventilation is provided by exhaust type ventilators in the roof. Smith hot water heaters are used for heating both types of cars. The 60-ft. car is equipped with one hot water heater which is placed in the baggage room. The articulated car has a heater located in the baggage room and one at the rear end of the passenger compartment. All of the pipes used in the heating system are of aluminum.

The Articulated Car

Each unit of the articulated cars consists of two bodies mounted on three four-wheel trucks. As shown in the floor plan of the articulated car, the front half contains the engine room, baggage room and smoking compartment which has a seating capacity of 35 persons. The rear half has a seating capacity of 91. The partitions between the engine room and baggage room are of steel and are so constructed that they can be removed if necessary to work at the power unit. Roof hatches are provided directly over the engine and generator so that either may be removed by a crane for repair purposes. The hatch covers are provided with four ventilators operated from the engine room.

The Sixty-Foot Car

The seats in the 60-ft. car are of the same design and manufacture as those of the articulated car. They accommodate three persons on one side and two on the other. In addition, the baggage room of this car is provided with drop seats of wooden construction giving a total seating capacity of 57.

The Engines

The engines installed in these cars were manufactured by William Beardmore & Co., Ltd., London, England. The design is a modification of this company's standard aeroplane engine which was changed to meet the service conditions of rail car operation. These engines conform to a modified Diesel cycle of the solid injection four-stroke cycle type and are arranged with four cylinders in line for the small unit which is used on the 60-ft. car, and eight in line for the large unit which is used on the articulated car. The cylinders in both engines have 8¼ in. bore by 12 in. stroke and develop 185 b. hp. at 700 r.p.m. in the small unit and 340 b. hp. at 650 r.p.m. in the large unit. The engine in the 60-ft. car weighs 2,750 lb. and that in the articulated car weighs 5,450 lb., or a fraction under 15 lb. per horsepower for the smaller engine and slightly more than 16 lb. per horsepower for the larger engine.

The low weight per horsepower was obtained through the selection of materials. The designers were able to reduce the thickness of the materials to a minimum through the use of high tensile steels and special alloys. For example, the crank case is of cast steel; the cylinder liners are made of forged steel; the cylinder heads, of cast aluminum; the valve seats, of alloy steel; the pistons, of forged aluminum; the crank shaft of special forged alloy steel; the sump cover, of sheet steel; and the connecting rods, of special forged steel. The exhaust from each cylinder enters a manifold on the side of the engine

from which one exhaust pipe for every four cylinders is carried vertically up through the roof.

A light residue oil of .86 specific gravity is used for fuel. It passes through two fillers before being delivered to the distributing plunger pumps, of which there is one for each pair of cylinders.

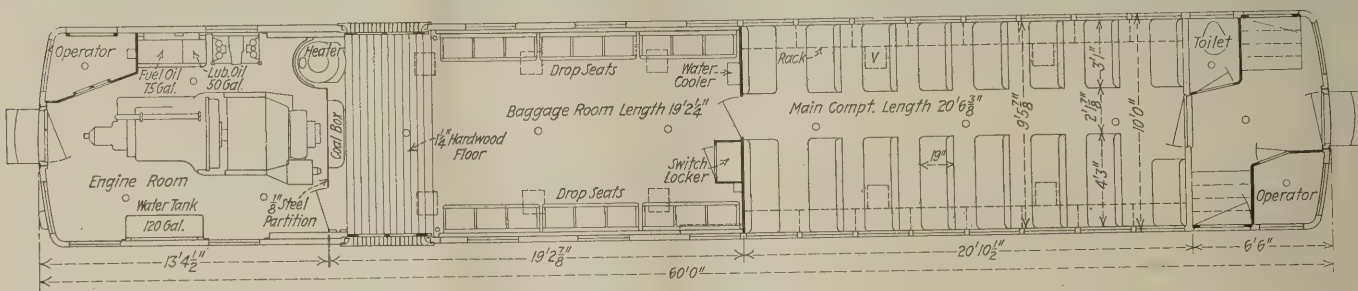
These pumps deliver the fuel to the atomizers at from 8,000 lb. to 10,000 lb. per sq. in.

Electrical Equipment

The electrical equipment on the articulated car was manufactured by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., and consists of a which also makes the entire operation practically automatic.

The air for the magnet valves is taken from the air brake system and is maintained at about 70 lb. pressure, the electro-pneumatic control being the standard H.L. equipment throughout. The acceleration of the car is practically automatic as the control can be thrown to the "full" position, allowing the sequence drum to increase the generator voltage in four or five seconds. All controller positions are, of course, running positions, and lower speeds than the maximum can be obtained by intermediate points on the controller.

The engine is started by the generator driven as a



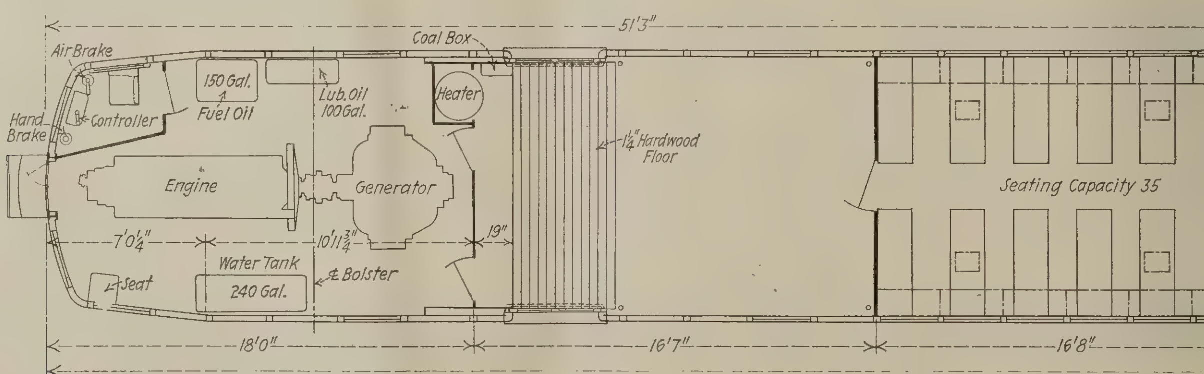
Floor Plan of the 60-Ft. Motor Rail Car

200-kw., 600-volt d.c. generator mounted on a common bed plate with the engine and connected to it by a Fast flexible coupling. Pressed felt liners 1½ in. thick are placed between the bed plate and the car sills to absorb vibration.

The generator is differentially compound wound, the shunt field being excited from a 300-volt battery. The motors are 600-volt railway type 548-C-8, with a one-hour rating of 145 amp. connected permanently in parallel and mounted two on each of the front and rear trucks and connected to the axles by helical gearing.

The car is operated by master controllers located at each end, different speeds being obtained by a resistance control of the main generator field. Besides the master motor, from the 300-volt battery, this starting position being obtained from the controller by moving the operating handle contrary to its operating direction. The engine starting position is also the battery charging position when the car is standing. By motoring the generator the 300-volt battery brings the engine to a speed of about 200 r.p.m. at which speed it fires on the first compression, the starting current for about two seconds being a maximum of 480 amp. down to 230 amp. at 150 volts. The battery voltage is applied to the generator through resistance steps and at the same time the engine throttle is moved by an electrically controlled air cylinder to full fuel position.

The battery is composed of 150 cells, M.V.A. 17 Exide

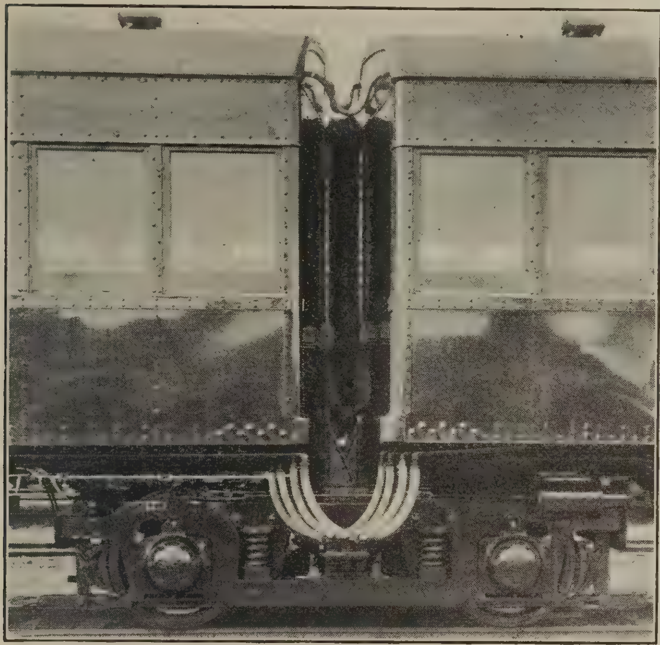


Floor Plan of the Articulated Motor Rail Cars Recently

controllers, the main control apparatus consists of a switch group comprising eight electro-pneumatic switches, two reversers, an overload trip relay, and a sequence drum. The auxiliary control apparatus consists of a potential relay, an ampere hour meter, a battery charging relay, a field relay, a throttle valve, a control and reset switch and the necessary knife blade switches for the control of the several circuits. False operation of the various circuits is prevented by necessary interlocking between controls, Ironclad, and is located in two sections in steel boxes suspended from the floor of the rear half of the car. With the car running and the controller on either of the last two notches, the potential relay cuts in and allows the generator current to charge the battery. This continues as long as the controller is on either of the last two notches or until the charging current is cut off by the ampere-hour meter.

Besides being used for starting purposes, the battery

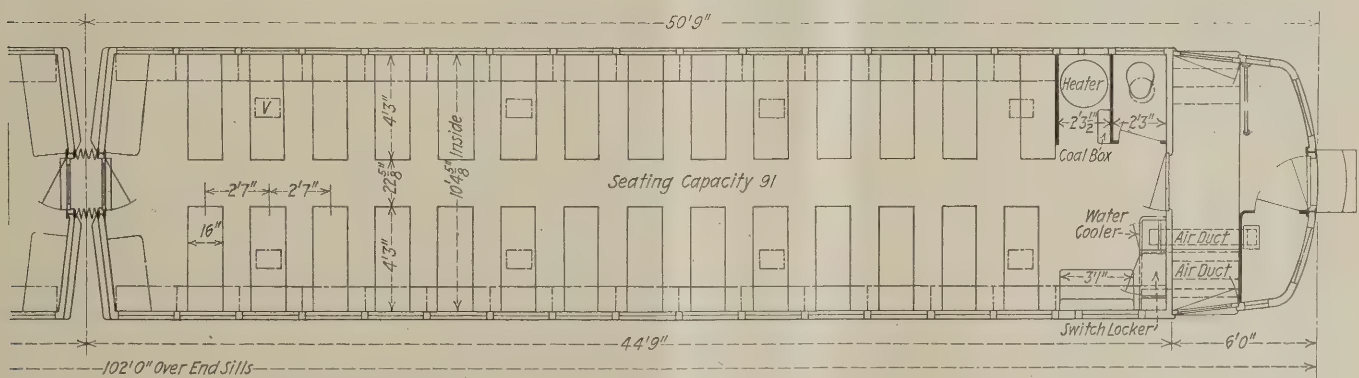
also supplies the control circuits at 30 volts; the generator field excitation at 300 volts; the two air compressors at 300 volts, and the car lighting at 30 volts. Low voltage circuits can be distributed over 90 of the 150 cells and standard lamp regulators are used to compensate for the



Exterior View Showing the Center Truck and Connections Between the Two Units of the Articulated Car

charging voltage. Emergency switching is provided so that any of the 30-volt sections can be charged from the generator while the car is standing. One of the main reasons for having the 300-volt battery is that in case of necessity, owing to a total engine failure, the car can be moved on half voltage to the next siding, in order to clear the main line.

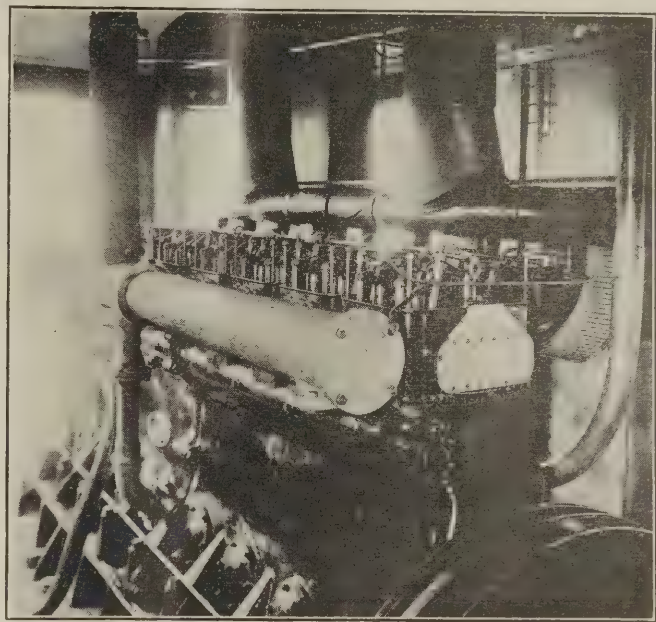
In carrying the circuits across the articulation, every effort has been made to secure accessibility and reliability. All the control wires are carried through the ceilings of



Placed in Service by the Canadian National

the cars, terminating at each side of the articulation in junction boxes located in the car ceiling. The only heavy cables crossing the articulation are the generator bus lines to the motors, the battery line to the generator and the train line lighting circuit. By locating a reverser on each half of the car, the necessity of carrying the motor leads across the articulation is avoided. Multiple unit control has been installed so that two or more cars can be operated from any one operator's position.

The electrical equipment of the 60-ft. car was manufactured by the British Thomson-Houston Company, Rugby, England and the General Electric Company, Schenectady, N. Y. The generator, which was shipped with the engine from England, is a 105-kw., 600-volt d.c. differentially compound wound machine mounted on a common bed plate with and rigidly connected to the engine. Pressed felt liners 1½-in. thick are placed between the car sills to absorb vibration. On the same shaft with the generator is mounted a 6-kw. 60-volt exciter. The balance of the electrical equipment con-



The 340-H. P. William Beardmore Oil Engine Weighs Only 5,450 Lb.

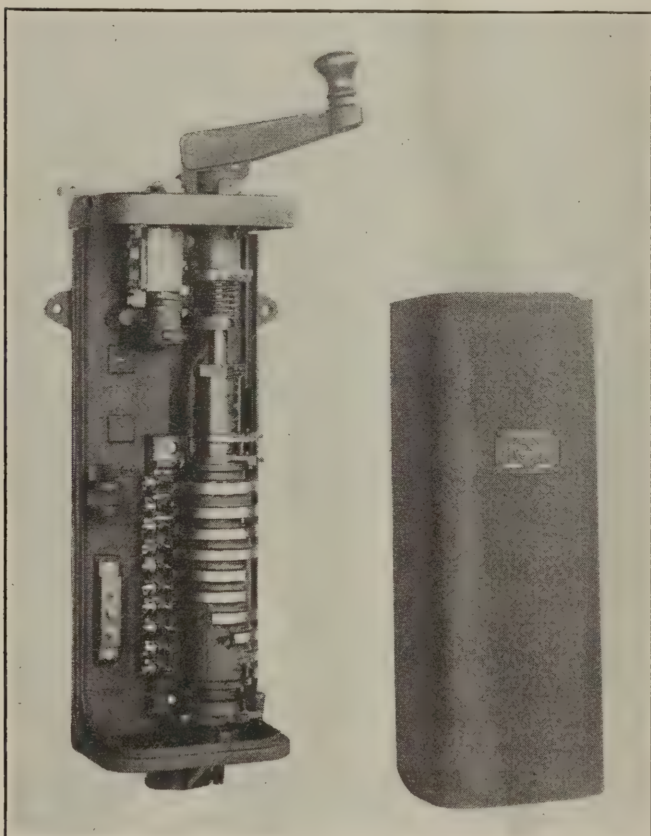
sists of two G.E. 240-A, 600-volt, 150-amp. (one hour rating) railway motors, mounted on the front truck and connected through helical gears. The controllers located at each end connect the motors in series, parallel or shunt field forward, and series or parallel reverse.

A 120-volt M.V.A. 17 Ironclad Exide battery is carried underneath the rear of the car. Thirty cells are suspended from the floor in a steel battery box on each side of the car. This battery furnishes starting current for driving the generator as a motor in a manner similar to that described for the articulated car, only 16 cells of which, however, supply the excitation of the exciter field and the car lighting. The 120-volt battery is charged from the generator by a special charging circuit used

while the car is standing. The 32-volt portion is automatically charged by the exciter when its voltage is higher than the battery voltage.

The car speed is controlled by the engine throttle, which is mechanically connected to an operating lever located in the operator's cab at each end of the car. The electrical controllers merely connect the motors to the generator circuit in series or parallel and are not used to operate the car. The first movement of the throttle lever closes the throttle relay switch, thus closing the exciter field circuit, and allowing the generator voltage to build up from zero across the driving motors. A further opening of the engine throttle increases the generator voltage and, therefore, the car speed.

The lubricating oil for the engines is forced under pres-



Double End Control Is Used with Westinghouse Type 28 M Master Controllers

sure to all working parts, passing through a double filter in its circuit.

A centrifugal pump is used to circulate cooling water through the engine. This pump is mounted on the main gear case and can be easily detached for examination. Flow indicators are installed in the lubricating oil and cooling water circuits which indicate a stoppage of flow by lighting a lamp in the operator's room.

A centrifugal type governor driven off the crank shaft is coupled to the fuel pump control and is so arranged as to increase or decrease the oil supply to the fuel distributing system. It is fitted with an emergency device to cut the fuel pumps out of action should the r.p.m. of the engine for any reason be increased above the desired speed.

A 12-in. Golden-Glow headlight is mounted on the roof at each end of each car. The Canadian National standard number lamps and Strombos horns are also provided, as shown in one of the illustrations.

Midwest air filters are applied to all of the cars for filtering the air supply to the engines. The filters used on the 60-ft. car are mounted on the ceiling of the engine room, while those on the articulated car are mounted on the left-hand wall of the engine room which is provided with shutter inlet to keep out the rain or snow.

The Trucks on the Articulated Car Are Equipped with Roller Bearings

The three trucks of the articulated car are of Commonwealth design having 5-in. by 9-in. journals and 36-in. rolled steel wheels. The journals are equipped with S.K.F. self-alining roller bearings. Motors are mounted on the front and rear trucks only.

The brake equipment is Westinghouse, schedule A.M.F. The air pressure on the articulated car is supplied by two DH-16 compressors connected in parallel.

Compressed air for the 60-ft. car is supplied by a General Electric CP28-D compressor. The front truck carries two motors and has 5-in. by 9-in. journals. No motors are used on the rear truck which is equipped with 4¼-in. by 8-in. journals.

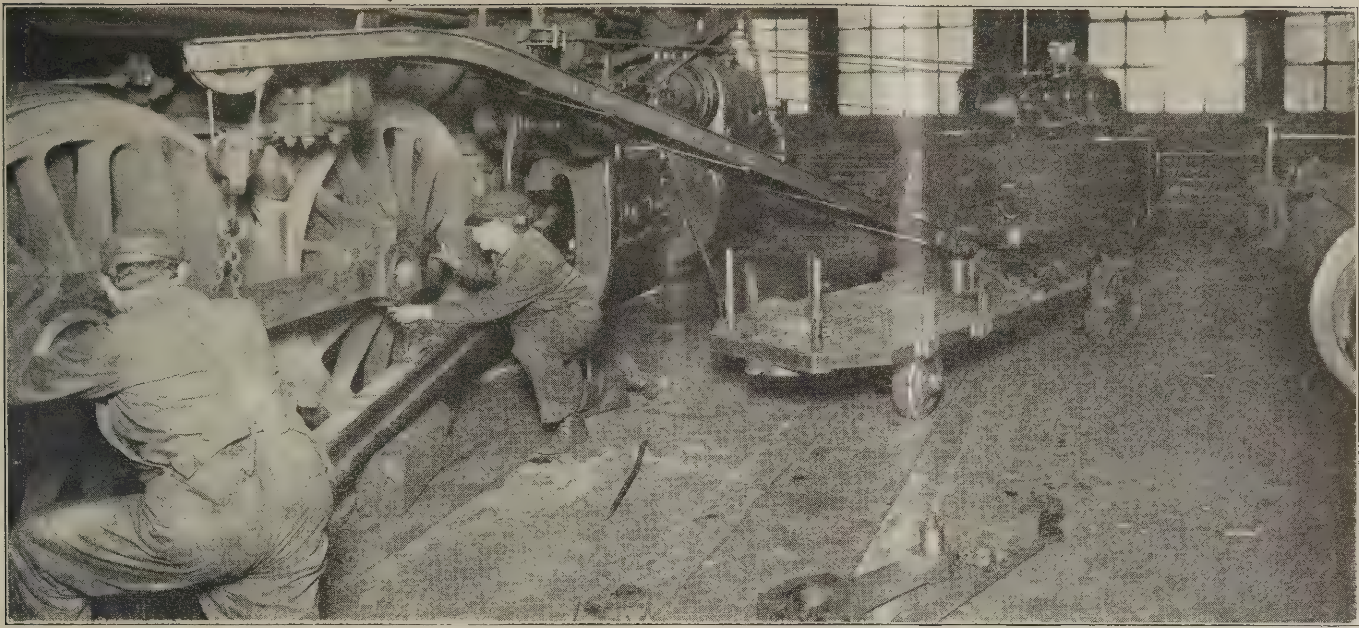
It is reported that both cars have attained a speed on level track of approximately 60 miles per hour and show a fuel consumption for non-stop runs of 3.5 miles per gallon on the large car and 7 miles per gallon on the small car. Both cars have sufficient power to handle a trailer over an average profile at a proportionally reduced speed. Car accelerations up to 40 and 30 miles per hour respectively have been made in actual test.

Principal Dimensions and Proportions of the Canadian National Diesel-Electric Cars

	60 ft. cars	Articulated cars
Builder	Canadian National	Canadian National
Type	Diesel-electric	Diesel-electric
Total weight	101.000 lb.	188,000 lb.
Total wheel base	46 ft. 1 in.	85 ft. 10 in.
Diesel engine:		
Builder	William Beardmore & Co., Ltd.	William Beardmore & Co., Ltd.
Type	4 cyl., 4 cycle	8 cyl., 4 cycle
Rated Capacity	185 b.hp. at 700 r.p.m.	340 b.hp. at 650 r.p.m.
Cylinders, diameter and stroke	8¼ in. by 12 in.	8¼ in. by 12 in.
Weight	2,750 lb.	5,450 lb.
Generator:		
Type	Thomson - Houston, 105 kw. d.c.	Westinghouse 200 kw. d.c.
Voltage	600	600
Motors:		
Number	2	4
Type	General Electric Type 240-A	Westinghouse, 200 hp.
Capacity of fuel tanks	75 gal.	150 gal.
Length over couplers	60 ft.	102 ft.
Width, inside	9 ft. 5⅞ in.	10 ft. 4⅝ in.
Height, overall	15 ft. ¾ in.	15 ft. 4⅜ in.
Diameter of wheels	36 in.	36 in.
Size of journals	5 in. by 9 in., front truck, 4½ in. by 8 in., rear truck	5 in. by 9 in.
Total seating capacity	57	126

Compounds of a certain melting point begin to soften before the melting point is reached, and they must be heated somewhat in excess of the melting point before they reach varnish fluidity.

For instance a compound that "melts" at 100° C.—212° F. may require 125° C.—257° F. before it becomes sufficiently fluid to penetrate or actually impregnate; and it is quite evident that the temperature of the armature, coil or other device to be impregnated must be raised to the same point through and through so that the molten material will not "chill" and become too viscous to penetrate the innermost interstices.—*Everything-In-Insulation.*



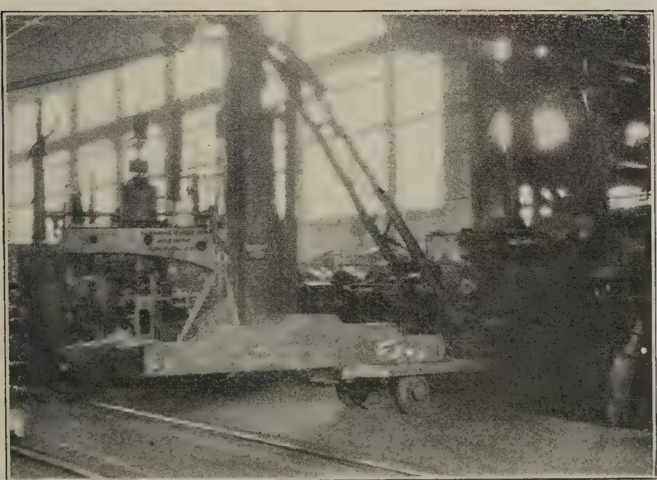
The crane type truck as it is used for applying side rods

Electric Trucks in the Locomotive Repair Shop

The Practice of One Railroad Indicates That This Equipment Fills a Definite Need

By Harold J. Payne
The Society for Electrical Development Inc.

THE size of modern steam locomotives is so great and construction is so complex, that the problem of stripping and rebuilding requires special facilities. The overhead traveling crane is indispensable in this connection and given sufficient time, can handle all of the work to be done. In the particular shop in question, however, 40 locomotives are placed at a time in each of two buildings and although each building is equipped with two cranes, it is still found that this apparatus is not equal to the number of tasks imposed upon it. Since in addition to the boiler tubes, 125 or more parts have to be taken off and replaced on each engine that is completely overhauled, this can be readily understood.



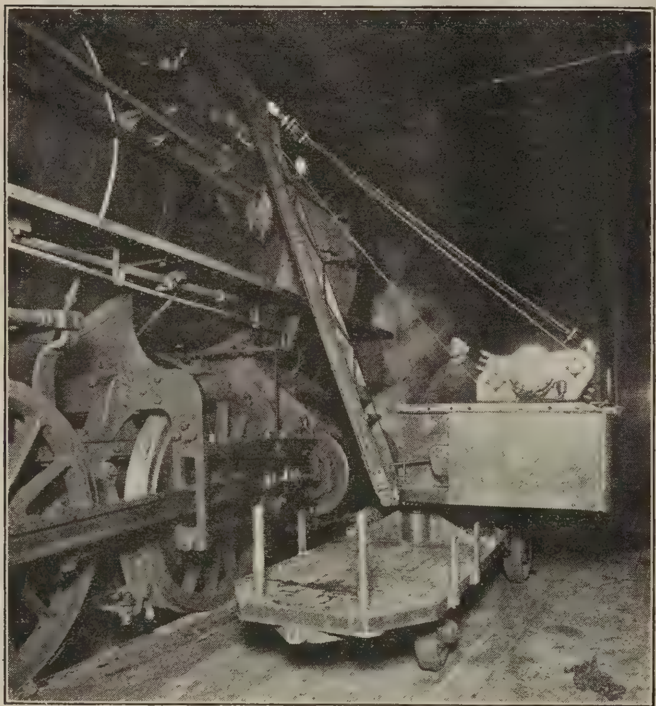
Large Castings Are Carried on the Chassis with the Aid of the Crane

Another class of work for which it has very commonly been found difficult to find adequate equipment in such shops is the handling of parts from the locomotive to the various sections of the repair shop where cleaning, machining, forging, annealing, etc., are done. Distances are frequently long, parts are heavy and are moving between points that vary considerably in location from hour to hour—especially as in this case where 80 locomotives are being repaired simultaneously. Quite evidently any carrier that is to work out in such service must be at the same time sturdy in construction and flexible in operation.

Storage Battery Trucks Adopted

With these two problems in hand the shop under discussion decided about four years ago to experiment with storage battery trucks as a possible solution of these difficulties. The original idea was to provide auxiliaries for the heavy cranes and for hand trucks. That being the case two types of truck were put into the service, the load carrying crane and the elevating platform. At present the management finds itself convinced not necessarily of the particular make of equipment nor the particular modification in use, but of the suitability of trucks for this kind of service. It can be said that each of the eight machines in service does more work than five hand truckers. The more or less intangible results that have been achieved, however, are of still greater importance.

The most important of these is the supplementary service rendered the overhead cranes. Formerly when a part was ready to be raised or lowered, it was necessary for the crew to wait for the overhead crane; time was unavoidably lost since it was a physical impossibility for two such machines to be in a half dozen places at a time. With the crane trucks now performing all of the lighter jobs the traveling cranes are always available for the work for which they alone are fitted such as lifting a rear end or front end or perhaps moving a boiler. By far the larger number of parts stripped weigh under three tons and are located within easy reach of the boom of the crane truck. Consequently, this work has been largely assigned to these auxiliaries, with the result that taking down and building have been generally accelerated. Furthermore, idle time on the part of repairmen has been cut down and in some cases the number of moves necessary to perform a given job has been decreased. For instance, when a couple of driving rods are taken off that are needed im-



The Boom Is Long Enough to Remove Parts from the Top of the Locomotive

mediately in the machine shop, the crane truck drops them onto the platform of its own chassis and delivers them to the machine that is to do the work, traveling a thousand feet and back again, probably dropping a load of finished parts by a nearby job on its return. By the time it is needed again for another job, on the locomotive being stripped, it is ready.

Work Done by Elevating Platform Trucks

The elevating platform type of truck with skids supplements the crane type in the work of moving the parts through process. Wooden platforms and metal box skids are used in connection with these trucks which are constantly on the move between the locomotive shops and the other departments. In general the metal boxes are used in the blacksmith shop for taking parts that are still hot directly from the workman or the machine, as the case may be, so that rehandling may be altogether avoided. The wooden platforms are used for all parts up to three tons, a typical load consisting of six or eight locomotive truck springs. It is impossible to detail the jobs done by the storage battery equipment because of the fact that it is used very much as are machine tools. In other words, the truck is a tool called upon to lift, carry or pull, irrespective of the nature of the job, so long as the total load does not greatly exceed the known capacity of the trucks, a

An Elevating Platform Truck Used As a Tractor

capacity somewhat greater than the two tons in this particular case, which is guaranteed by the maker. Perhaps by citing a few "odd jobs" for which the trucks have indicated fitness through their performance, a somewhat clearer picture of what they are accomplishing may be gained.

Saving on Chip Removal

Formerly nine wheelers were busy all day long keeping the machine shop clear of chips. The distance that had

Chips Are Carried Out and Dumped into Scrap Cars with the Crane Type Trucks

to be traveled to the siding on which the car was placed that carried away these chips frequently exceeded 1,000 feet and always included a curving up grade of about 6 per cent, 40 feet long. When the crane trucks came into use the experiment was tried of carrying out the chips in cans, each holding the equivalent of six wheelbarrow

loads. On every trip the truck carried four to six of these containers. The net result of this innovation has been a reduction of the labor involved to that of two truckers, each with one helper, working only one hour and 20 minutes a day. The congestion caused by nine wheel barrows constantly moving through the shop has been eliminated. This was particularly gratifying as the aisleways are exceedingly narrow considering the volume of material necessarily constantly on the move. Actually the main runway through the machine shops that are placed at right angles to the locomotive shops, is not over seven feet wide.

Boiler tubes when removed for cleaning and safe ending are placed behind the locomotive on a special flue wagon that runs on standard gage track. When the load is ready, it is run out onto the transfer table and from the table to the flue shop. Formerly 10 men were required for placing the flue wagon on the table and later for pushing it into place in the shop. By the method at present in use, a truck of the elevating platform type

Elevating Platform Used for Unloading Wheels from a Car

is used to haul the load of tubes. The truck is coupled to the flue wagon and the machine used as a tractor has no difficulty in moving the load. One man can do the job in a shorter time, and entirely without physical effort, that formerly demanded 10 men normally at work on other jobs.

Special spring bumpers have been attached to the front end of the platform trucks to fit them for shoving loads that may be placed from time to time on other wagons or push cars that run in the main aisleways on a standard gage track. Again the trucks are used in spotting cars when a switching engine is not immediately available. Regularly the platform trucks work between the stores department and the various sections of the plant delivering such supplies as may be needed. With equal regularity the crane trucks are used for loading outbound motor trucks carrying heavy stores for shipment to other plants or roundhouses. The complete flexibility of the crane truck is a great advantage in such loading where quarters are tight and overhead cranes are not available.

Building a Transportation System

It is clear that in order to keep all of this fleet of 8 units operating efficiently at all times, a transportation organization is desirable. This has been recognized and one man has been given complete charge of the equipment and is entirely responsible for service rendered. The foremen in charge of various sections of the shop are expected to make known to him any special work that is to be done. To speed up movements and to reduce the number of empty runs, a system of flags has been adopted for placing on work waiting to be moved. These are small metal markers, painted yellow with a black letter designating point of destination. The first driver passing such a job without a load is expected to pick it up and move it. The transportation chief is constantly alert throughout the various shops making sure that no jobs are being neglected and dispatching the truck drivers for special work when need arises. Special effort has been made in assigning definite jobs to various truckers to reduce the time to a minimum that they must travel empty.

Although costs of operation are not known definitely at this shop, other data reveal that a charge of $4 a day per truck covers the items of interest, depreciation, maintenance and power in similarly heavy service. Beside saving five times the wage of a hand trucker at a cost of about $4, many worthwhile changes are made possible in shop routine.

Eveleigh Locomotive Shops, New South Wales Rys.

Headlight Turbine Adapted for Bench Lathe Work

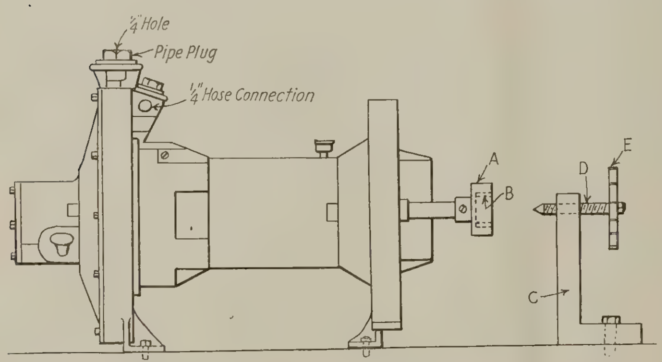
By V. T. Kropid

Shop Electrician, C. & N. W. Ry., Winona, Minn.

At a point where the roundhouse is quite a distance from the back shop it was seen that considerable time could be saved if the round-house had a small lathe for chasing up threads on washout plugs and for other light work. As it was, the men had to go to the back shop to do this work.

No authority could be gotten for the purchase of such a machine, at least for some time, so the idea of adapting a headlight turbine for this service was advanced.

An old type E Pyle National turbo-generator unit was



Type E Pyle National Turbo Generator Used for Chasing Up Threads on Washout Plugs, Buffing Work, Etc.

available, and it was decided to put this into commission.

The front field frame together with the field winding and the armature were removed and on the protruding end of the shaft a brass face plate, *A,* was secured. This face plate has a square hole to take the square end of a washout plug, bushings *B* are provided for different sizes of washout plugs. Bracket *C* with screw center *D* and hand wheel *E* forms the tail-stock. The square end of washout plug is inserted in the square hole of the face plate and the centering screw of the tail-stock is made to engage the center punch of the washout plug. Chaser dies are used for chasing up the thread.

Of course, it was necessary to reduce the speed of the turbine to a practical limit. This was accomplished by choking the exhaust, so as to maintain a certain back pressure in the turbine wheel chamber and thereby checking the velocity of outflow from the expansion nozzle. A few trials had to be made before the right speed was obtained. With a ¼ in. hole in the exhaust and a ¼ in. inlet and about 75 pounds air pressure a speed of 150 R.P.M. of the turbine wheel is secured which is about right for all around purposes.

Since this had been put in service the round-house crew has found many other schemes for which this turbine can be used, such as light grinding, by applying suitable emery wheels in place of the face plate on the end of the shaft, for buffing work, wood turning, etc.

Effect of Temperature on Tantalum Electrolytic Rectifiers

The effect of temperature on electrolytic rectifiers is clearly pointed out by C. E. Stryker, electrical engineer of the Fansteel Products Company, Inc., of Chicago, who makes the following interesting statement:

We have made tests on Balkite rectifiers, at temperatures as low as 10 deg. below zero, Fahr., and as high as the boiling point of the electrolyte, which is somewhat above the boiling point of water. We were unable to detect any great difference in the charging rate between the above mentioned extreme ranges in temperature. In fact, I do not believe the charging rate varies more than 10 per cent over the entire range. It is, therefore, absolutely safe to state that for any practical use the charging rate is independent of temperature.

The freezing point of the sulphuric acid electrolyte used in the Balkite rectifier is slightly above zero, Fahr. This does not mean, however, that the rectifier will cease to function, if the temperature of the outside air goes below zero. As long as the current is flowing through the rectifier, which is the condition of normal use, the rectifier will not drop to a temperature below the freezing point of the electrolyte and the electrolyte will, therefore, never freeze. Even if power should be interrupted and the rectifier be allowed to stand idle for some time, the freezing will not bring any injurious results. The reason for this is that the sulphuric acid electrolyte does not freeze into a solid block as does water, but rather freezes into a slush. If the rectifier has reached this condition with the power off and the power is later turned on, it will start to function almost immediately and will restore the electrolyte to its normal condition within a very short time. Under such conditions the rectifier would not start to charge at the normal rate but would probably start at a rate only a fraction of normal; but it would be only a short time before it reached normal rate.

It may be of interest to state that the Balkite rectifiers operated on one of the northern railroads, with outside tem-

peratures lower than 30 deg below zero, Fahr., for a period of several weeks without any indication of abnormal operation. The rectifiers were examined at the end of this protracted period of low temperature and were found to be in normal condition. The batteries at that time, were in a fully charged state, which indicated that the rectifiers had functioned normally during the period of low temperature.

Do You Get Me?

There's a new string of words that tethers our goats;
  Do you get me?
From the Bird who is windy and feeling his oats;
  Do you get me?
Who broadcasts a lot of slithering slush;
With ideas like flies in a pot-full of mush
And winds up his talk with the gibbering gush
  "Do you git me?"
This Bird *knows* the answer to various things;
  Do you get me?
His romantic soul soars high on its wings;
  Do you get me?
He trails Dame Rumor right into her lair
If a scandal is brewing, he's camping right there
And he winds up his spiel by saying "Beware—
  Do you git me?"
He talks about circuits and signals and such;
  Do you get me?
He figures the rest of us know nothing—much;
  Do you get me?
On matters most simple he'll draw us a map
Make us feel like a boob or a yammering yam
And say, with a gulp, as he closes his trap—
  "Do you git me?"
Some day I shall load my big forty-four;
  Do you get me?
This *quartet* of words will be said then no more;
  Do you get me?
We are tired of feeling dull, dense and dumb
So we'll rid this earth of a *composite* bum
And curtail that phrase—in the ages to come—
  "Do you git me?"

Do You Believe in Signs?

When the wind moans it is extremely bad luck to burn rubbish near your buildings.

A crack in your chimney is a sure sign you are going to move.

To see a paperhanger papering over a flue indicates an impending loss.

If you can see your shadow from an oil lamp, while filling the tank of a gasoline stove, it indicates a gathering of old friends at your house.

If you smell gas or gasoline and look for it with a lighted match, it foretells that you are about to go on a long journey.

A Kick in the Licker

Yardmaster—"What did that switchman lick you for?"

Lampman—"Just plain jealousy, that's all. He got sore cuz I'm such a big, strong feller an' he's nothin' but a little bit of a shrimp."

Misery Loves Company

Friend (in railroad official's office to said official)—"I notice that your clerks are all in a fine humor; have you been raising their wages or something?"

Official—"Not so you could notice it. To be frank, it's just because my wife has been in here and it tickles them to death to see someone boss me around."

The Difference

He was not a traveling man. That much was noticed by a clerk in the consolidated city ticket-office.

"Let me have sleeping car accommodations on the train to New York," said the man, approaching the clerk, cautiously.

"For a single passenger?" asked the clerk, smiling.

"No," replied the man. "I'm married; but I am not taking anybody with me. A single shelf will answer, I suppose."

"Upper or lower?" again asked the clerk.

"What's the difference?" asked the passenger.

"A difference of about $4," answered the clerk.

The passenger paused as he fumbled his money, and the clerk explained:

"You understand, of course, the lower is higher than the upper. The higher price is for the lower berth. If you want it lower, you'll have to go higher. We sell the upper lower than the lower. In other words, the higher the lower."

"Why do they all ask for the lower?" asked the man.

"On account of its convenience," replied the clerk, hastily. "Most persons don't like the upper, although it's lower, on account of it being higher, and because when you occupy an upper you have to get up to your bed and then get down when you get up. I would advise you to take the lower, although it's higher than the upper, for the reason I have stated, that the upper is lower than the lower, because it is higher. You can have the lower if you pay higher; but if you are willing to go higher, it will be lower."

For a time it seemed as though it would be necessary to call an ambulance and send the bewildered customer to a hospital.—*Exchange.*

The Late Miss Smith

Chief Clerk (to stenographer)—Do you know what time we start to work in this office, Miss Smith?

Stenographer—I can't say. They are all hard at it when I arrive.

He Fooled the Engineer

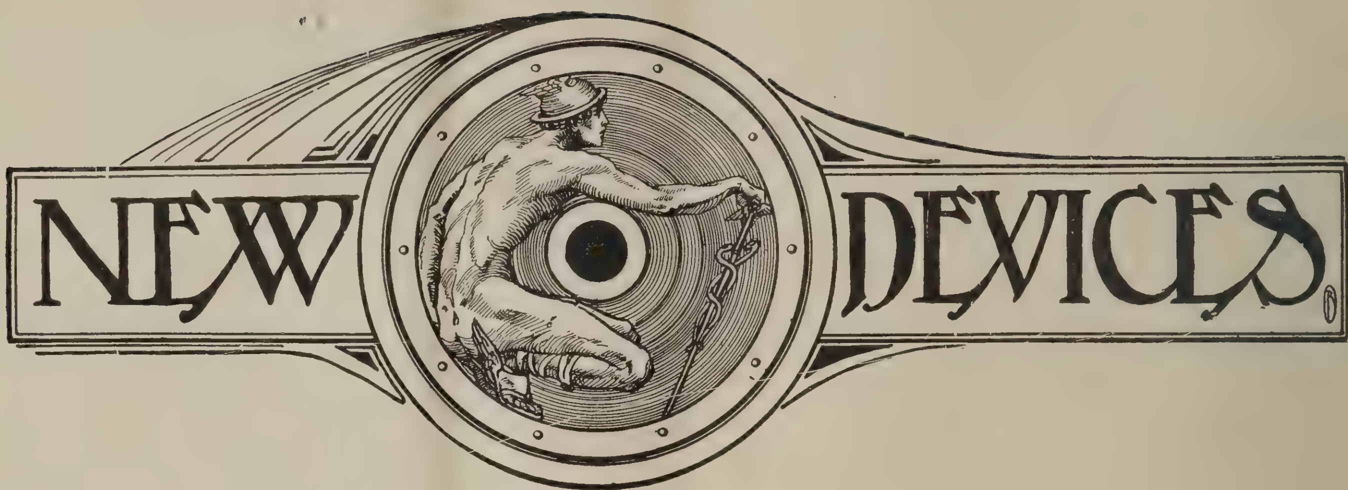
Doctor (examining unconscious engineer)—Did that automobile hit the engine?

Fireman—No, the driver slowed up to let the train go by and the engineer fainted.

Force of Habit

Passenger (formerly telephone girl)—"Porter, why didn't you call me as I told you?"

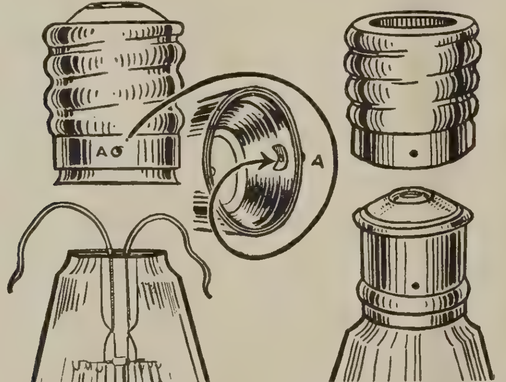
Sleeping-Car Porter—"Ah did, lady. Ah sho' did. Ah sade 'Seben-thirty, ma'am,' and you said, 'Line's busy.'"



Improved Theft-Proof Lamp

An improved type of the Kulp theft-proof lamp is now available which can be used either as an ordinary bulb, removable from the socket, or as a theft-proof lamp so that one stock of lamps can be used for both purposes.

The principle is simple. The threaded shell is held rigidly to the base by the small pin and washer (a). The lamp is inserted in the socket as usual until contact is made. If an extra twist is given, this pin is sheared off, allowing the lamp and base to turn freely in either direction while the shell remains in the socket. To remove, the bulb is broken, after which the shell may easily be



Exploded View Showing Base and Shell Assembled, Base and Shell Separate and Shear Pin Which Prevents the Base from Turning in the Shell

reached and unscrewed. Since the lamp can only be removed by breaking, incentive to theft is removed.

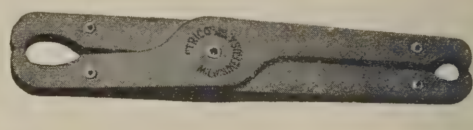
The lamp itself is standard, carrying standard guarantees and sold at standard prices and discounts, exactly the same as for ordinary lamps. No changes in sockets are necessary and no extra attachments required. The patented theft-proof feature is part of the lamp base, built into the lamp at the factory.

The possibilities of this lamp in railroad service are apparent for shops, stations, freight houses, office buildings, round houses and other exposed places. Figures submitted by some railroads show an annual loss from the theft of lamps varying anywhere from 15 to 30 per cent of their lamp purchases. One large system writes off $13,000 a year in this way. A smaller line admits to $3,000 loss in ten months. These are suggestive figures, rendered all the more important since the entire amount can be saved.

These lamps are manufactured in all standard sizes and types by the Kulp Theft Proof Lamp Co. of Chicago and sold and serviced to railroads by the E. A. Lundy Co. of Pittsburgh.

Puller for Large Fuses

The Trico Fuse Mfg. Company, Milwaukee, Wis., is now making a puller for large fuses, known as the Giant Fuse Puller and Replacer. This puller is similar to, but larger, than the Pocket Size Fuse Puller made by the same company. It is 12 inches long and made with 7



The Trico Giant Size Fuse Puller and Replacer

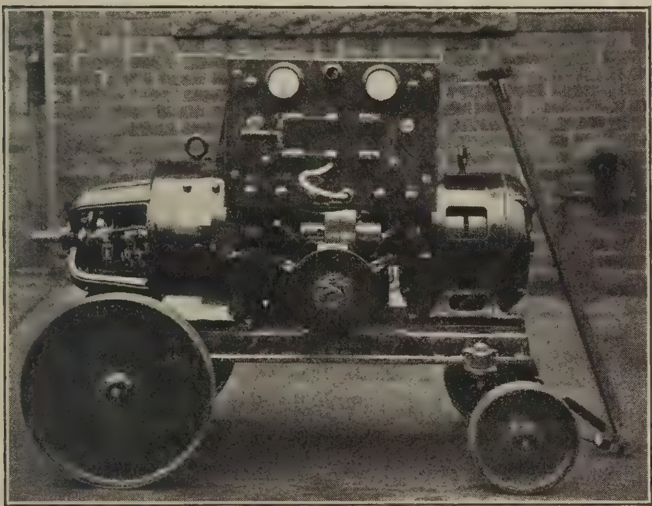
laminations of the fine gray horn fibre, securely riveted at all points subject to strain. Inserts placed between the laminations give a firm, even grip on the fuse and prevent any tendency to twist or slip in the hands of the user. The large size puller and replacer is designed for use on fuses from 100-600 amp., 250 V. and 60-400 amp., 600 V.

Dual Current Welding Generator

A generator designed to develop both alternating and direct current for arc welding purposes has been recently brought out by the Electric Arc Cutting & Welding Company of Newark, N. J. The machine is being marketed under the name of "Dualarc" generator, and it is built by the designers to meet the demand for a single machine which will embody all of the advantages which have been attributed to both a.c. and d.c. arc welding. The entire apparatus has but one involving unit which is ball bearing and may be driven by any form of power motor, or by any available line shaft delivering 5 to 7½ hp.

The entire set is guaranteed to operate continuously for all arc welding without vibration. It is possible to short circuit the generator without injury, as the voltage simply falls to a low value holding the maximum current constant. It can be left in this short circuited condition indefinitely without injury. The field coils are so arranged

that they may be connected either as series compound or series differential so that both carbon arc and metallic arc requirements are provided for. The machine is not separately excited. The field windings are wound on steel bobbins and baked solid in enamel before being mounted rigidly on the poles. The poles are then mounted rigidly in the frame and disassembly can be made in the same manner.

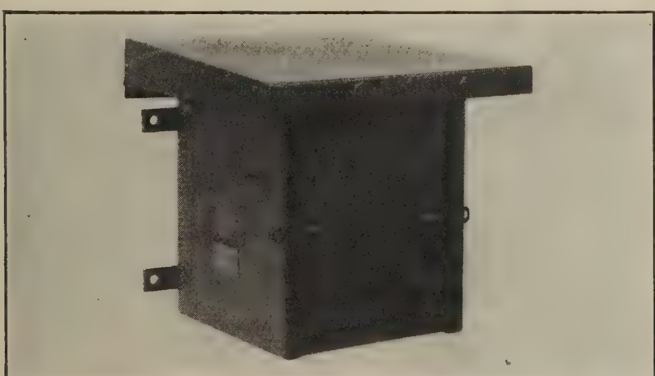


Combination A. C. & D. C. Welding Generator Equipped with Motor Drive and Mounted on Truck for Portability

The armature is one complete baked unit with d.c. commutator and a.c. collector rings interval, each ball bearing and frame is demountable separably. There is a shaft extension on both ends of the generator so that air compressors or other power take-off can be utilized. The generator will operate in either direction and the voltage and current are adjustable independently.

Weatherproof Magnetic Switch

A special form of the type CR-7009 magnetic switch made by the General Electric Company is provided with a weather-proof enclosing case and roof for use in valve control service where operating conditions require that the switch be located in an exposed place, or in other similar conditions where it is necessary or desirable to locate the control nearer the motor.



Magnetic Switch With Weatherproof Enclosing Case

All seams and supports of the outside case are turned, to eliminate surfaces where water might collect. The roof is slanting and overhangs the case on all sides to allow water to fall away. The case itself is provided with a special finish to meet the service conditions.

An additional improvement is a change in the method of latching the doors, using a new latch. Possible jamming of the lock strip, or failure to latch tightly due to inaccuracy in location of the slot are thus prevented.

Unique Fire Extinguisher

A fire extinguisher, known as the Rego Fire Stopper, which has a number of unique features, has recently been developed by the Bastian-Blessing Company of Chicago. The first noticeable feature of this extinguisher is its appearance. The device is composed of two main units: a cone shaped container which is filled with dry powder and a small tank which is filled with CO_2 gas under pressure. When a fire is discovered, the device is turned up-side-down, the valve on the gas tank opened and the resulting stream of powder is directed at the base of the flame. When the fire is out, the valve is closed and the tank returned to an upright position. Only as much powder as is actually necessary to put out the flame is used.

Position of Extinguisher When in Use

The principle upon which the extinguisher is worked is that the powder in coming in contact with the flame, generates CO_2 gas and immediately blankets the entire fire and effectively smothers the flame. The use of CO_2 for power gives the device an effective range of from 25 to 30 feet. It is claimed that the extinguisher will put out all kinds of fire including those involving electric wiring. The powder is a non-conductor of electricity and can be used with safety in extinguishing electrical fires up to 160,000 volts.

General News Section

Daylight saving, as a general policy has been rejected by the state of Maine, the voters of the state, in a referendum, having decided against the plan by a large majority.

The automatic train control apparatus which is being installed on the Baltimore division of the Pennsylvania is the Union continuous track circuit control and forestaller.

The Central of New Jersey has been authorized by the Interstate Commerce Commission to install automatic train control between Elizabethport, N. J., and Bay Head Junction, N. J., in lieu of the section named January 14, 1924, in the second train control order.

The Interstate Commerce Commission has extended from January 1, 1926, to July 18, 1926, the effective date for the completion of the installation of automatic train control on the New York, Chicago & St. Louis required by the commission's order of June 13, 1923.

A report of progress in the construction of the Moffatt tunnel through the Continental Divide on the line of the Denver & Salt Lake west of Denver on December 15, shows that the pioneer or water tunnel and the main headings in the main tunnel are 76 per cent finished, while the main tunnel has been excavated to full section for a distance of 11,343 ft. in from the east portal and 4,463 ft. in from the west portal, a total of 15,806 ft. or 49 per cent of the total distance.

"Certificates of Mechanic" will be issued by the Chicago, Rock Island & Pacific to all its shop apprentices who have completed their four-year apprentice course in Rock Island shops. These certificates will bear the name of the graduate apprentice, the number of years he has served and the place of his employment, and will be signed by the superintendent of motive power and the master mechanic of the shop where the apprentice completed his course. The certificates will be engraved and appropriately decorated.

The Chicago, Rock Island & Pacific, according to an announcement made by the Regan Safety Devices Company, has ordered the installation of the Regan automatic train stop on its line from Davenport, Iowa, to Des Moines, Iowa, 174 miles. The number of locomotives to be equipped is 50. This contract covers the section of road named in the second order of the Interstate Commerce Commission and when the work shall have been completed, the whole of the government requirements will have been met; 339 miles of road, 150 locomotives.

The Pullman Company is offering its employees an opportunity to purchase 10,000 shares of its stock at $140 a share, to be paid for at the rate of $3 a month. Any employee of three months or more service with the company will be entitled to subscribe for one or more shares of stock based on his annual salary. The employee will pay 4 per cent interest on the unpaid balance due on his stock which carries a dividend of 8 per cent. The Pullman Car & Manufacturing Corporation is also offering its employees the opportunity to purchase stock on similar terms.

The Boston & Maine announces the conclusion of an arrangement with the Canadian Pacific under which 104 miles of leased lines operated by the Boston & Maine are to be operated hereafter by the Canadian Pacific. The territory covered is that from Wells River, Vt., northward through St. Johnsbury and Newport to Lennoxville, Que., 101 miles (70 miles in Vermont) and the branch from Beebe Junction, Que., to Stanstead, Que., three miles. The Boston & Maine was promoted by the belief that these lines, because of their extreme northerly location, could be operated to better public advantage by the Canadian road, with resulting operating economies to both roads.

One Hundred Dollars for a Name

The Chicago & Eastern Illinois is offering $100 for a name which can be used as a trademark for the railroad. A prize of $50 is also offered for the second best suggestion. T. C. Powell, president, is endeavoring to secure a nickname or trademark which will catch the eye, be expressive and be adopted by the public. The name must indicate the position and service of the railroad. The company has found that due to their simplicity, nicknames of railroads are retained and used by the public more frequently than the corporate names and feels that such a name for the C. & E. I. is desirable.

Westinghouse Institutes Prime Mover Sales Department

Effective January 1 the prime mover sales activities of the Westinghouse Electric and Manufacturing Company will be conducted by a new sales organization to be located at the South Philadelphia works. This announcement was made by E. D. Kilburn, vice president and general sales manager of the Westinghouse Company. The personnel of this new department will include the following appointees: Howell Van Blarcom, formerly assistant to the manager of the power department at the South Philadelphia works, to manager of the prime mover sales department. R. E. Carothers, formerly manager of the steam division of the power department at the East Pittsburgh plant, to assistant manager of this new department. A. H. Ganshird, formerly of the large turbine section East Pittsburgh plant, to manager of the large turbine section of the prime mover sales department. C. G. Ong, formerly of the central station division, Boston office, to manager of small turbine section of the prime

mover sales department. P. L. Fetzer, formerly of the condenser section, East Pittsburgh, to manager of condenser section of the new department.

D. T. & I. Employee-Stockholders

At the second anniversary of the Detroit, Toledo & Ironton investment certificate plan, 1,406 of the 2,966 employees, or nearly 48 per cent, had accumulated $479,391 under the savings plan. Of this amount $444,200 in certificates was held by employees and the balance, $35,191, represented the sum on hand toward the completion of payments. The average individual account was $341. During the past year deposits have increased over 95 per cent and the average individual accounts have increased nearly 105 per cent, but the number of employee-depositors has decreased 15 per cent. Four interest payments have been made during the past two years to holders of certificates, based on the earnings of the road. For the first two periods returns were based upon a 12 per cent annual dividend and for the last two six months' periods upon a 16 per cent yearly rate.

Greer College Buys Big Electrical School

Greer College of Automotive Engineering of Chicago has just purchased from the U. S. Government, the United States Veteran Bureau Electrical Trade School on Karlow Avenue, Chicago. This is one of the most completely equipped electrical trade schools in the United States. The equipment has been moved to the establishment of the college and the government's former leading instructor has been engaged to teach men the electrician trade. Courses include instructions in practical electricity, direct current, alternating current, high tension lines, house wiring, armature wiring, motors, generators, etc.

Oil-Electric Locomotive in Chicago

The oil-electric locomotive, which has been introduced for switching service by six of the railroads in New York City, has been added to the equipment of one of the railroads in Chicago. The Chicago and Northwestern Railway is obtaining one of the 60-ton locomotives for service in its Chicago yards.

The locomotive, produced jointly by the Ingersoll-Rand, American Locomotive and General Electric Companies, is like the units which are being supplied the Central Railroad of New Jersey, the Delaware, Lackawanna and Western, the Baltimore and Ohio, the Lehigh Valley, and the Erie for service in New York. The Long Island Railroad is obtaining a 100-ton unit for similar service there.

South African Electrification

The South African Railways have completed the electrification of their line from Glencoe Junction to Pietermaritzburg, 171 miles. The line is equipped with automatic substations and is the largest railroad electrification in the world to be so equipped. The road experienced such an increase in business that extensions of facilities became imperative. There was a choice between double tracking or electrification and the engineers decided to electrify. This is the first railway electrification in South Africa, and is being followed by the electrification of the Capetown suburban lines.

Twelve 3,000-volt automatic substations were required in electrifying the railroad. Standard three-unit sets of 2,000-kw. capacity are used in all stations; four stations being equipped with one machine each, seven with two machines, and one with three machines. The power is generated at Colenso, 112 miles from Pietermaritzburg. The station equipment includes five turbo-generator sets, each with a continuous rated output of 12,000 kw. at 6,600 volts, three-phase, 50 cycles. Transmission is at 88,000 volts. At the substations the power is reduced to 6,600 volts and converted to 3,000 volts direct current by the synchronous motor-generators. Provision is made for the operation of all these sets inverted, in case the regenerated current from the locomotives exceeds the requirements of other trains taking power. The average substation spacing is 15½ miles, and there is practically no stub-end feed since a substation is located at both Glencoe and Pietermaritzburg. The substation equipment was furnished jointly by the British Thomson-Houston Company and the International General Electric Company. Each of the automatic equipments is designed for local and remote control.

The reports of Merz & McLellan, the consulting engineers, who recommended electrification rather than double tracking the Natal lines, emphasized several advantages to be gained thereby, as follows: Electrification required no more time than would have double tracking. The net capital outlay was small when compared with the annual saving in working expenses resulting from electrification. There are several tunnels, some very long and one or more through which it would not be feasible to double head steam trains. Electrification eliminated the danger of grass fires and the expense thereby entailed in applying fire breaks outside the fence. Short adjoining lines can be electrified at comparatively small expense. Many of these branch lines have severe grades and are difficult to operate with steam equipment. Fewer trains are required, and more uniform speeds are possible. The coal formerly used for locomotive purposes is available for shipment, and low grade fuel formerly regarded as waste is utilized for the power station.

The present freight traffic approximates 20,000 gross tons per day from Glencoe southward, together with some passenger traffic. The estimates for electrical operation are based on the assumption of 30,000 gross tons daily except Sunday in the southward direction, and approximately half this tonnage northward.

Stops Eliminated on the Rock Island

Joseph Beaumont, vice-president of the Regan Safety Devices Company, speaking on automatic train control before the Engineers' Club of Philadelphia, on November 17, reported results of using automatic train control on the Rock Island as being highly profitable in doing away with the need of stopping trains at "stop-and-proceed" signals. He said, in part:

"Automatic train control is not alone a safety proposition. It is also a vital matter affecting the earning power and capacity of the railroads. Automatic train control—including speed control—will pay handsome returns per dollar invested. Having installed speed control to insure safe speed when passing a stop-and-proceed signal, there is no need to stop at such signals to insure that the train is under control. Such has been the practice for two years on the Illinois Division of the Chicago,

Rock Island & Pacific; 165 miles of double track and 102 locomotives, equipped with the Regan automatic train control system.

"A systematic analysis was made during September last to determine the exact number of stops actually eliminated by operation under this automatic train control system. Enginemen were instructed that when a train was compelled to stop because of a train in the block, even after passing a signal, under enforced low speed without stopping, that this should not be considered as a stop eliminated by automatic train control. The results of this check showed that an average of 132.1 freight train stops and 12.8 passenger train stops were eliminated per day—an average of 48,216 freight and 4,672 passenger train stops eliminated per annum. This is equivalent to 7,045 freight train hours per annum and a substantial figure for passenger trains which has not been computed. This analysis covered a 30-day period—September 15, 1925, to October 14, 1925, inclusive.

"As the result of more smooth operation with the Regan system the Rock Island has been able to space its trains far more efficiently under the principle of spacing trains by enforcing restricted speed at automatic block signals."

A. L. Salt

F. A. Ketcham

G. E. Cullinan

Graybar Electric Company Takes Over Western Electric Supply Business

The electrical supply business carried on by the Western Electric Company has been set apart from the telephone manufacturing business and incorporated under the name of Graybar Electric Company. This gives to the supply department a separate identity which is made necessary by its importance as the largest merchandiser of electrical apparatus and related equipment in the world. Since it came into existence in 1869 as the partnership of Gray & Barton, the name which it now resumes in modified form, the supply business has grown steadily until it now has 55 distributing houses in important cities. The Western Electric Company has been both the manufacturing company of the Bell System and a distributor of electrical supplies. Both of these lines of business require specialized organization and specialized management. The rapid expansion of the supply department made an entirely separate corporate identity even more necessary.

Physical separation of the two departments of the Western Electric Company was carried out in 1923 with the opening of general offices for the Supply Department in the Pershing Square Building, New York. The advent of the Graybar Electric Company into this field as the successor to the Western Electric Company therefore involves comparatively few changes.

This is one of the very few instances in business history, if not the only one, where a corporation has reverted to its original designation as a basis for its corporate name after such a lapse of time and a period of such tremendous growth. The new name is particularly appropriate since the company is carrying on a business continuing that of the original partnership as it would have developed without the changes caused by the invention of the telephone and the advent of the manufacture of the telephone.

The Graybar Electric Company has distributing houses in Albany, Atlanta, Baltimore, Birmingham, Boston, Brooklyn, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Davenport, Denver, Detroit, Duluth, Grand Rapids, Harrisburg, Houston, Indianapolis, Jacksonville, Kansas City, Los Angeles, Memphis, Miami, Milwaukee, Minneapolis, Nashville, Newark, New Haven, New Orleans, New York, Norfolk, Oakland, Omaha, Philadelphia, Pittsburgh, Portland, Providence, Richmond, Salt Lake City, San Antonio, San Francisco, Savannah, St. Paul, St. Louis, Seattle, Spokane, Syracuse, Tacoma, Tampa, Toledo, Worcester and Youngstown. Sales of the Supply Department of the Western Electric Company amounted to $50,000,000 in 1923 and $66,000,000 in 1924.

In 1869, Enos M. Barton, a telegraph operator, obtained four hundred dollars by mortgaging his mother's home to help buy an interest in an electrical shop managed by George Shawk in Cleveland. Electricity was too much of a speculation for Shawk and the ups and downs of business worried him so that in the same year he retired in favor of the partnership of Gray & Barton. Elisha Gray's inventions became one of the chief assets of Gray & Barton. The company reorganized in 1872 and became the Western Electric Manufacturing Company, one-third of the stock being sold to the Western Union Telegraph Company, an arrangement which brought more business and more equipment. In 1877 the Western Electric Manufacturing Company made its first telephone instruments. The Western Electric Company succeeded the old company in 1881, and became the following year the manufacturing headquarters for the Bell Telephone System.

Notwithstanding the importance of the telephone department, however, there was no relaxing of enterprise in the field of electrical supplies. The year-book of the Graybar Electric Company with more than a thousand pages in 1926 compares with a twenty-page catalog of three decades ago which consisted chiefly of remarks about bells and buzzers.

The Graybar Electric Company will continue the sale of all devices and materials which constituted its business under the Western Electric name. Apparatus such as motors, generators, electric lamps, industrial and other lighting equipment, household appliances, and the like, formerly sold under the Western Electric name, will now be sold under the trade name of Graybar. The company will continue to market equipment of Western Electric manufacture, such as telephone train dispatching apparatus, intercommunicating telephone systems, lead-covered cable, etc. It will be concerned with radio through its sale of broadcasting apparatus and other radio telephone equipment which the Western Electric Company may manufacture. Other supplies entering into the Graybar business will be pole line equipment, schedule material, wire, accessories for electrical contractors and dealers, carrier current systems, etc.

The Graybar Electric Company thus perpetuates the memory of Elisha Gray and Enos M. Barton, both of whom contributed a great deal to the advancement of the industry. Mr. Barton continued as president of the Western Electric Company until 1908, and he was chairman of the board until his death in 1916. Professor Gray was the forerunner of the engineering department which played a vital part in the history of the company and the application of electricity.

Albert Lincoln Salt, president of the new Graybar Electric Company, began his business career in 1881 as a temporary office boy in the New York office of the Western Electric Manufacturing Company. Mr. Salt had finished grammar school, and his connection with business was supposed to last only through the summer after which he was to go to school again. Instead he was promoted within a fortnight to mail clerk, and when the time for school came his parents were prevailed upon to let him work days and study nights. This he did until he reached the age of 25. He advanced to the positions of assistant bookkeeper and cashier, and in 1886 was made shipping ticket clerk and later placed in charge of billing. In 1892 he was placed in charge of the retail sales and general clerical work. During the period of 1895-1899 he was assistant manager of the New York office in charge of telephone sales and purchases, and in 1900 succeeded to the dual position of assistant telephone sales manager and general purchasing agent. Mr. Salt was placed in charge of the traffic arrangements for the telephone companies in 1898. In 1913 he was elected vice-president of the Western Electric Company in charge of purchases and traffic. He has been a director of the Western Electric Company since 1915. He is also president of the Manufacturers' Junction Railway Company of Chicago.

Frank A. Ketcham has been appointed executive vice-president of the new company. He was born at Saginaw, Michigan, and attended the University of Michigan. He started his business career with the Western Electric Company at Chicago in 1900 and five years later held the rank of telephone storekeeper. He was advanced to the assistant managership in 1907, and in 1911 was appointed manager. A short time after, he was promoted to the title and duties of central district manager. Mr. Ketcham became general sales manager of the Western Electric Company in 1918, and in 1923 was appointed general manager of the Supply Department which had been separated from the Telephone Department in 1921.


L. M. Dunn


E. W. Shepard


N. R. Frame

George E. Cullinan, vice-president in charge of sales, entered the statistical department of the Western Electric Company immediately after his graduation from Williams College in 1901. In 1907 he was transferred to St. Louis. He became assistant manager at St. Louis the following year and in 1909 was promoted to the position of manager. Later he became Western district manager with headquarters in St. Louis, and this was followed by a transfer to Chicago as manager of the Chicago distributing house and Central district manager. In January, 1923, he came to New York as general sales manager of the Western Electric Supply Department.

Leo M. Dunn has been appointed vice-president in charge of merchandising and accounting. Mr. Dunn went to work at the age of 11 in March, 1886, as an office boy with the Central District Printing & Telegraph Company of Pittsburgh, an operating telephone concern associated with the Western Electric Company. In 1910 he was chief storekeeper of the Pittsburgh distributing house of the Western Electric Company. He became manager at

Pittsburgh in 1913, and manager of the Philadelphia house in 1918; the next year he was made assistant Eastern District manager. Two years later he was transferred to New York as manager of the New York distributing house and Eastern district manager. He became general merchandise manager of the Supply Department in 1923.

Elmer W. Shepard, who has been appointed treasurer has held the position of general credit manager of the Western Electric Company since 1918. Mr. Shepard was born in Winona, Minnesota. His first job was that of office boy for the Chicago Great Western Railroad. He was employed in the auditing department of the Western Electric Company at Chicago in 1906 where he remained until 1908 when a transfer and a promotion made him cashier and credit man at the Indianapolis office. He returned to Chicago in 1911 in the credit department, and two years later was advanced to the rank of credit manager at Cleveland. In 1918 came his appointment as general credit manager of the company.

N. R. Frame, who has been appointed secretary of the company, began his business career as an office boy for the firm of Hard & Rand, coffee merchants of New York. Subsequently he worked for a real estate concern, and then determined to study law. He is a graduate of the Horace Mann School, and took special work at Columbia and Teachers College in economics and preliminary legal work. He began the study of law with a year at Albany Law School, and his course was completed by two years at New York Law School. He entered the offices of Barber, Watson & Gibboney as clerk and later became managing clerk. He was associated with F. Campbell Jeffery in the practice of law, first as assistant, and later as partner. In May, 1923, Mr. Frame joined the Western Electric Company as attorney in the legal department, a position from which he is advanced to the secretaryship of the new company.

The capitalization of the Graybar Electric Company is $15,000,000, all of the stock being owned by the Western Electric Company. The directors of the new company include the president, the three vice-presidents; Charles G. Du Bois, chairman, and the following executives of the Western Electric Company: Richard H. Gregory, comptroller; Howard A. Halligan, vice-president; George C. Pratt, general attorney, and William P. Sidley, general counsel.

Personals

F. L. Williamson, formerly sales manager for the Taplet Manufacturing Company, Philadelphia, has been appointed eastern sales manager for the Chicago Fuse Company, effective December 1, 1925. Mr. Williamson will have his headquarters at 71 Murray Street, New York. He will have supervision of sales in the New York and Philadelphia territories, covering the New England states, Eastern New York, New Jersey, Eastern Pennsylvania, Delaware, Maryland, District of Columbia and Virginia. Mr. Williamson has been identified with the electrical industries in the east for many years having served as manager of the New York office of the Economy Fuse Company from 1915 until 1923 at which time he became associated with the Taplet Manufacturing Company as sales manager.

Henry C. Houck, assistant general merchandise manager of the General Electric Company, has been appointed manager of the merchandise department at the Bridgeport works of the company.

Mr. Houck entered the employ of the company in 1899 in the testing department. On completion of his course, he was transferred to the lighting department and, in 1902, was sent to the Cleveland office as lighting apparatus salesman. In the 10 years that followed, he became manager of the supply department in the Cincinnati district manager. In 1912, he was recalled to Schenectady as assistant manager of the supply department. In 1922, when the merchandising department was formed, he was made assistant to G. P. Baldwin, then manager, who was promoted to a vice president in charge of railroad electrification activities.

L. C. Hensel, formerly chief electrician of the Chicago & Alton, on December 1, 1925, entered the service of the Edison Storage Battery Company in the railway department at Chicago. Mr. Hensel was born December 12, 1878, at Port Jervis, N. Y., and was educated in the high school at Hawley, Pa., and at the Wyoming Seminary at Kingston, Pa. He was constructional electrician during 1901 and 1902 with the Lackawanna Steel Company, Buffalo, N. Y. He first entered railway service as an electrical foreman on the Frisco on July 7, 1903, and was made electrical engineer in 1908. From July, 1917, to May, 1918, Mr. Hensel was plant superintendent for the Gould Storage Battery Company at Depew, N. Y., on the building of submarine storage batteries. He returned to the Frisco in May, 1918, as electrical engineer and remained in this position until his resignation on May 5, 1924. He was appointed chief electrician of the Chicago & Alton as noted above on January 7, 1925, with headquarters at Bloomington, Ill., which position he held at the time of his recent connection with the Edison Storage Battery Company.


L. C. Hensel

Trade Publications

The Rome Wire Company, Rome, N. Y., is publishing a series of bulletins dealing individually with every type of wire. The first two, dealing with magnet wire and Super Service Cord, have received wide distribution. The third, dealing with bare wire, is now ready for distribution. This bare wire catalog contains useful data and tables regarding constructions, sizes, weights, current carrying capacities, etc., and makes a handy book for reference. The Rome Wire Company will gladly send copies of any of these bulletins to those who express their interest.

Railway Electrical Engineer

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Repair Shop Equipment

Elsewhere in this issue is an article entitled "Test Board for Train Lighting Shop," by N. Hansen. This is the first of a number of articles describing various machines and devices designed and built in the Southern Pacific shops at Oakland, Cal., and used by the train lighting department in the repair and maintenance of train lighting equipments. The author is assistant foreman electrician in direct charge of the train lighting repair shop at West Oakland and is responsible for most of the many ingenious devices described in these articles. Among the devices described will be an armature testing stand, a coil dipping stand, an armature press, a coil winding machine, an armature winding stand, a lamp dipping rack, testing apparatus for type E-2 Pyle-National headlight armatures, a belt cutter and a battery truck.

There are several reasons for presenting this group of articles. The shop is remote from the supply market and necessity has created a demand for the equipment and practices employed. As a result new and unusual practical ideas have been worked out. Many of the devices can be used to advantage in other shops or may be applied in principle to other classes of work. These devices will be described, one at a time, and in sufficient detail to make it possible for any one to build duplicate equipment for his own use.

The Shop Inventor

There are certain men of the inventive type who are constantly making new devices which will do some particular job quicker and usually better than the old way of doing it. The railroad shops are not without their quota of embryo inventors and some of the things these men turn out are remarkably ingenious. The *Railway Electrical Engineer* is always glad to publish descriptions of devices of this kind.

There is, however, one weakness that most of the railroad shop inventors seem to possess in common, and that is, they do not give sufficient study to the development of their ideas before beginning the actual construction of the machine or device. This fault usually results in building a piece of apparatus which works, but upon which improvements are apparent almost as soon as the device is finished. It would not be altogether fair to say that the shop inventor is alone in this failing. It is a condition that is representative of many large industries today. Manufactured machinery often becomes obsolete quickly because of some revolutionary improvement which will meet the requirement much better.

That manufactured apparatus should be improved is, of course, inevitable for there are few products that can be considered 100 per cent perfect. It is a good idea, however, so far as the shop inventor is concerned, to give abundant time to the study of his device before attempting to build it; to try in every conceivable way to improve upon the original idea with a pencil and paper before the actual construction work is begun. In nine cases out of ten, the extra thought will be well worth while and will result in cutting the subsequent improvements to a minimum.

"Just Till They Don't Spark"

Every electrician knows that if a solenoid or an electromagnet be grasped with the right hand, so that the fingers point in the direction of current flow, the thumb will point toward the north pole of the coil or magnet. It is a simple rule which is published in almost every treatise on fundamentals of electricity. It explains a principle, it is easy to remember, and it has a useful although somewhat limited application in the work of the average electrician.

Seafaring men know that red channel buoys mark the left hand side of the channel when they are leaving port and that when they are coming into port these same buoys must, of course, be kept on the right hand side of the vessel. There are many such rules to remember and this particular rule is fixed in the minds of many as, "Red, right, returning." With this aid to memory one does not have to stop and think of the underlying principle or reason for the rule.

There is always the objection to rule-of-thumb methods, that the user will learn the rule and not understand the underlying principle. If he does this he will limit his own progress and there will be times when he will find it difficult to fit the rule to some unusual application of the principle. There are, however, many rules which might enjoy much wider publicity than they do.

For example: brush tension on high-speed direct-current machines, such as headlight generators, has received much attention in the form of study and experiment. As a result it is common knowledge that if brush tension is too low the brushes will spark, and if it is too high there will be too much brush friction which will overheat the commutator and possibly cause it to throw solder. Correct brush tension can be obtained with a spring balance, but it can also be done without it. A headlight maintainer on an eastern road was asked recently how he knew when he

had the right brush tension. He replied "I bring it up just till they don't spark." In the single expression "Just till they don't spark" he incorporated much useful information in a form that is easy to remember. Such information will probably be helpful to many readers of the *Railway Electrical Engineer*. Will you think about the rules you use in your everyday work and send one or two of them in for publication?

Welding Procedure Control

Fusion welding has been given an important place in the railroad shop. The welding art is still young and it is only reasonable to assume that the scope of welding will gradually be increased. If, however, certain definite things are not done for welding, it is quite possible that its use will be curtailed by edicts issued by state legislatures, the Interstate Commerce Commission or by railroad managements. Such rulings are not in keeping with the possibilities of welding, but may be made necessary by lack of uniformity of work done.

There is one way to assure continuously good welding and that is, by what is termed "Procedure Control." This consist essentially of proper training and checking of operators and effective and continuous welding supervision. It must be known that the material to be welded is weldable, the proper welding wire must be used, the weld must be properly designed, preheating or annealing must be used when necessary, the performance of operators should be checked periodically, welds should be inspected and should be tested when it is necessary.

Railroads and manufacturers who employ proper procedure control, know to what extent welding can be used, but if the opportunities of welding are to be realized, all roads should adopt a good system of procedure control. When this is done the future of welding in the railroad shop will be assured.

Outlook for Diesel Locomotives

The outlook for the Diesel Locomotive was discussed by Samuel M. Vauclain, president of the Baldwin Locomotive Works, in a paper before the Midwest Power Conference in Chicago on January 29. In substance, the outstanding factors which Mr. Vauclain said were affecting the future of the Diesel locomotive are included in the following paragraph.

The steam locomotive, which is the standard for comparison with any new form of motive power, occupies a strongly entrenched position from both practical and sentimental viewpoints. The Diesel engine has an over-all efficiency as high as 33 per cent, while the best steam locomotive shows only about one-quarter of this percentage. To compete with the flexibility and reliability of the steam locomotive, the Diesel locomotives must not be too complicated in detail or too heavy per horse power developed. The Diesel locomotive costs about 75 per cent more than a steam locomotive of the same capacity. Diesel locomotives now in service weigh from 275 to 400 pounds per horse power.

With a thermal efficiency three or four times that of a steam locomotive it would appear that the Diesel operated unit would be a formidable competitor of the steam engine even though the first cost of the Diesel is much greater. This would probably be the case except for the fact that under present conditions of development the total horse power output of the Diesel locomotive is limited. This means that while it may be used for moving heavy loads slowly or light loads at a relatively high speed it can not be used for moving heavy train loads at speeds required for main line operation. The Diesel locomotive, therefore, is now limited to switching and light traffic service. In the course of time engine capacities will be enlarged and, with increased production, locomotive costs will be reduced. If in the meantime there is no unforseen intervention, it seems logical to prophesy that through a period of years the use of the Diesel locomotive will gradually but surely increase in the steam railroad field.

Insulating Varnish Tests

A re-wound armature, especially if it is a large one, represents a very appreciable investment and it is the height of folly to put poor materials into it with the idea of effecting economy. The labor involved would be practically the same whether good or bad material was used and as the labor charge forms a large part of the cost for repairing armatures the only conclusion that can be justified is that the best materials obtainable should be used in doing the work.

In armatures for 650-volt motors the importance of insulation cannot be minimized and one of the most vital factors to be considered is the matter of insulating varnish. There are numerous companies manufacturing insulating varnish most of which claim remarkable characteristics for their products. Unfortunately many of the claims made exist only in the mind of the salesman or at least if they ever did exist in the product itself they have been gradually eliminated because of sharp competition. In short, it is seldom safe to believe everything that is stated on the label of a varnish can.

It has, therefore, become necessary, in order that only good materials shall find their way into armature construction, that samples of the varnish to be used be subjected to suitable tests to show whether or not the varnish should be accepted or rejected. There are a number of factors to be considered in putting the sample through such tests. These may be summarized somewhat as follows:

Surface drying time, hard drying time, cracking time, di-electric strength tests, volts at puncture, water absorption tests, heat endurance test, oil resistance test, ageing test and penetration test. There are a number of important characteristics which good insulating varnish should possess and while it might seem that this testing procedure is superfluous, experience has shown that such is not the case and that it is exceedingly unwise and costly to make extensive use of any varnish before its characteristics are thoroughly known.

It is comparatively an easy matter to devise the necessary equipment to make the tests outlined as simple apparatus is all that is required. Any shop can readily make these varnish tests and the time used in making them will be amply repaid.

General View of D. L. & W. Terminal, Hoboken, N. J.

Methods of Handling Car Lighting Equipment

An Outline of Maintenance and Overhauling Procedure as Carried On at the Hoboken Terminal of the D. L. & W.

By Geo. W. Wall
Car Lighting Foreman, Delaware, Lackawanna & Western R. R.

AXLE generator systems have proved to be both efficient and economical as a means of lighting suburban passenger equipment on steam railroads, and with the possible exception of a few favorable runs, provide a more satisfactory and flexible method than any other scheme tried on a large scale.

Short runs with frequent stops and comparatively long runs with few stops must be taken care of at all times with a minimum of attention and to maintain the apparatus properly it is necessary that information regarding the runs and the mileage covered by the cars be available.

One of the most important considerations connected with the lighting service is that each car should be self-supporting in this respect, and able to properly take care of itself on any run or series of runs so that the superintendent of car service may use the car at any time and at any place where it may be needed to meet the constantly shifting streams of travel, without the necessity of first inquiring as to the fitness of the car to be used as desired.

The equipment must be so adjusted and maintained that there need be no restrictions placed upon its use in meeting a sudden peak caused by some more or less local shift of travel which can not always be foreseen.

Operating Conditions Govern Maintenance

Modern steel equipment provides practically the same seating capacity in all cars and they are not assigned to given runs as much as formerly. When one car is crippled or additional cars required, the first available extra car is taken without asking questions, replacing the crippled car or providing the additional service. Obviously, when attention in regular maintenance routines is due, the yard force must check up the yard to locate the car, perhaps to find that it is out on the line or lying in some suburban yard from which it may not move immediately.

During the rush hours in the morning a "wanted" car may come in the yard only to leave again in a very few minutes. The breaking up of trains, extent of yards with miles of trackage, constantly shifting runs, etc., tend to make the problem of "first catching your car" a costly one and the cause of considerable lost motion as time is wasted trying to find a car or cars which may or may not be in the yards.

Despite the varying conditions of service under which the cars operate it *is* possible to develop a system of maintenance and regulation which will take care of the apparatus properly, leave the car free to run any place as desired and assure good illumination with economy. It is hardly possible to regulate the equipment so as to guarantee a fully charged battery at the end of all or even a majority of the runs, but it is quite possible to adjust the equipment to take care of all but the most difficult runs, and then, by devoting special attention to these runs, get satisfactory results with minimum effort. Usually, it is easily possible to locate the train used on the hardest runs and provide for any special attention without loss of time. As cars are shifted into and out of the train, the yard men can take care of them as required. In other words, it is the run, not the car, which causes the difficulty. Having once determined what the requirements of the particular run may be, provision is made to meet them as various cars are put in the train covering this service. The total number of trains which demand special attention is so limited that it pays to give the required special attention rather than attempt to so adjust all cars that they would take care of the extreme condition.

Economical operation evidently depends to a considerable degree on the reduction of inspections and avoidance

of the necessity of locating a car for work required as much as possible. The present day equipment with its high standard of uniform and reliable performance has reduced the necessity of inspection to a great extent with the result that the cost for labor and material is cut down to a very satisfactory figure as compared with some of the old records.

Practically all of the equipment now used in the suburban zone on the Lackawanna are steel, electric lighted cars. The maximum run is about forty miles and the minimum fourteen. About 80 per cent of the cars are required to handle the traffic on the fourteen-mile runs, a very considerable number of the cars making but one round trip per day. The number of cars required for operation during the non-rush hour periods represents a rather small percentage as compared to the total number required for the rush hour travel.

Constant shifting of the individual cars from one train to another complicates the problem of maintenance, but it is evident that the large number of short runs is the determining factor on which the system of maintenance must be based. Disposition of the men engaged in the suburban yards at the terminal and the routine and regulation system are arranged to meet the requirements of the bulk of the service without neglecting the conditions on the longer runs which while fewer in number, introduce the possibility of serious battery overcharge if the regulators are not correctly adjusted.

In order to maintain the electrical installatiion in the best working condition, it is necessary to adopt some

Applying Special Jack to Remove Ball Bearing

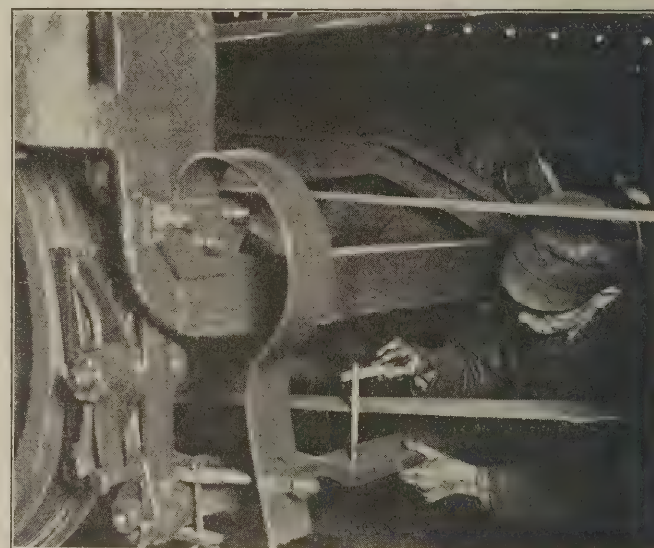
standard setting or adjustment for the various units and maintain those standards as closely as practical operation will allow at all times. It is, therefore, required that such settings and adjustments be worked out after careful checking of service results and adhered to as closely as possible at all times, so that those who have to maintain the apparatus may know what the standard is and maintain the various units at the required adjustment.

Checking Up New Equipment

The proper time to make the tests and settings to conform to standard is when the car is first put in service and check thereafter at every general overhauling. With the apparatus now available the adjustments once made, can be depended upon for long periods of time and it is only necessary for the maintenance force to check the actual results, to determine whether the equipment is operating properly and in such a manner as to meet the requirements of service and economy.

On the arrival of the new car from the shops of the builder, it is carefully gone over to determine whether any errors have been made in connections and adjustments.

Polarities of train line receptacles, charging receptacles, battery and equipment are checked, belt clearance and length are measured, pulleys tightened, interior of genera-



The Correct Belt Clearance Must Be Maintained or Trouble Will Result

tor inspected and equipment motored. All settings and adjustments of regulators are checked, fuses and lamps inspected to determine if correct, each car train-lined to determine whether it functions properly and if there are grounds, short or open circuits present. Serial numbers of various units are also taken for the equipment register.

The gravity and voltage of each cell in the battery as well as the height of solution is taken and corrected if required; all connections tightened, serial number and date put on the set. The table shown on this page covers the items of information taken from each series of cars on arrival from the builder and all this information is tabulated and made up into an equipment register. Every effort is made to keep the information up to date and in order to facilitate this, the sheets are made up on loose leaf form so they may be replaced by a corrected sheet as soon as any change is made in the equipment. Some of the information may appear to be of doubtful value, but the idea is to make available to all concerned a ready reference as to details which any one may require whether he is directly concerned in the maintenance of the equipment or not.

While the car builder and railroad inspector endeavor to see that all apparatus is properly installed, many opportunities for accidental changes or breakage occur between the date of shipment of the apparatus from the manufacturer to the arival of the car on the scene of its future activities. Only by carefully checking up on the

various parts can such defects be discovered and remedied before the car goes in service. Having made the necessary adjustments and alterations, the car goes into service and all parts of the equipment conform in every respect to the requirements of the service in which it is intended to be operated.

The time which will elapse before the car finally is released for shopping is supposed to be definitely set, but if the schedule were rigidly adhered to it would be the exception rather than the rule. The car is supposed to be shopped in eighteen months, but the actual time will average considerably more.

The Matter of Belt Length Is Important

EQUIPMENT REGISTER—ELECTRIC LIGHTED CARS

Car No.
Data equipped
New or old car
Class of car

Make and type of apparatus
System
Generator
Gen. regulator
Lamp regulator
Suspension

Generator
Type
Voltage
Amperes
K.W.
Bearings
Suspended
Pulley—ratio
R.P.M.—cut in full load
M.P.H.—cut in full load
Generator regulator
Type
Auto switch closes
Floating voltage
Max. ampere setting
Capacity of current coil

Lamp regulator
Type
Voltage setting
Capacity

Armature pulley
Diameter
Width
Flange
Shaft fit

Axle pulley
Diameter
Width
Flange
Car journal
Position on axle

Belt
Length (max.)
Width
Ply
Kind
Fastener

Fuses
Circuits
Generator—Armature
Field
Battery switch
Main light switch
Train line switch
Battery
Type
Number of cells
Capacity
Connection
Assembly units

Train lines
Number of conductors
Size
Capacity
Type receptacle

Fixtures
Cat. No.
Maker
Location

Reflectors
Name
Cat. No.
By whom furnished

Distribution of lights
Circuit No.
Number of lamps
Volts
Watts
Type
Location

Load on car
Lights—watts
amps.
Misc.—watts
amps.
Total—watts
amps.

Serial Nos.
List all parts having serial number

The first two years are comparatively easy to bridge as the equipment and battery are new and very little in the way of repair or replacement is necessary. Some parts may break down as they are all new, and defects will occur, but after a month or two at the most, all these troubles are smoothed out and the apparatus gives very little trouble

When the car is finally shopped, the battery is removed and the whole equipment is thoroughly overhauled.

Overhauling Done by Two Men

In most cases this work is handled by two mechanics, one handling the inside of the car while the other handles the generator and suspension. In order that neither interferes with the other, the inside man who handles the regulator uses a small motor generator set which furnishes current to operate the panels and the outside man immediately disconnects the generator and proceeds with the overhauling. Any special job or defect which has been noted while the car was in service is set down on a card carrying the car number and when the equipment is overhauled any changes desired or defects not previously permanently repaired are taken care of by the man handling the part of the equipment affected. Occasionally, helpers are put on the car to assist the mechanic if there is special work to do or time is limited. The helper acquires experience in this manner and the work is speeded up to keep up with the schedule.

It Is An Important Thing to Have the Polarity of the Charging Receptacles Correct

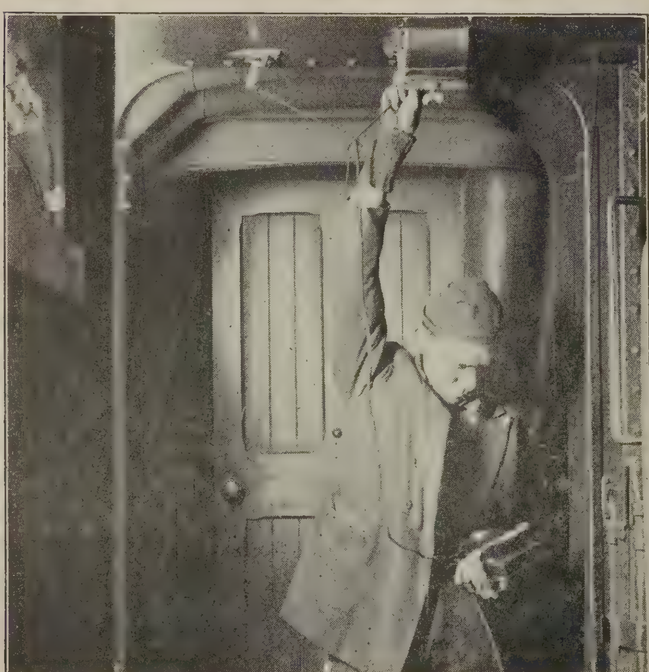
It is seldom that electrical defects are found in the generator. Mechanical trouble due to wear or loosening of parts due to vibration are mostly in evidence and the mechanic pays particular attention to the condition of the armature brushes, flexible connectors, pole changers, shaft, bearings and pulley of the generator as well as to the condition of the leads to the car body and connections to the terminal block. He must bear in mind that the machine, when leaving his hands, is presumed to be in con-

dition to run two years without trouble due to wear. If he is doubtful about any part, it is poor economy to try to get the last bit of wear out of it. Better to remove a small part and save future trouble. It may be thought that a short brush which may break or lose contact cannot do any other damage if it should occur, but it is quite apt to score the commutator or cause it to burn so as to cause failure, necessitating the removal of the armature for repair and perhaps tie up a revenue earning car if another armature is not at hand or time for its immediate application available.

Pole changers give very little trouble as wear is slight even in the suburban service. The pole changer operates much oftener during a given period in such service and somewhat more wear is evident than in through line service. At most, however, the wear is so slight that most of them have had no repairs in ten years and the main attention required is to see that the various bolts, nuts, screws, contacts, etc., securing the parts are kept tight and fit snugly, putting in new ones when they show signs of wear.

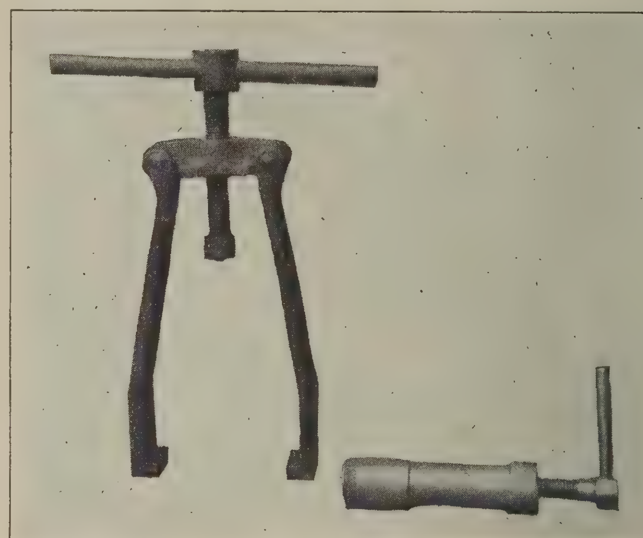
Bearings Receive Careful Attention

So much depends on the bearings that the greatest care is exercised to see that they receive proper attention. Some sleeve bearings are still in service on truck hung



Train Lines Are Tested at Terminal Boxes for Grounds and To Insure Proper Polarity

generators and as long as they run as economically in this service as at present there is hardly justification for a change to ball bearings. The change may be easily made however, if these generators should be put on the body of the car in which case ball bearings become particularly desirable. A good share of the fifty cars still equipped with sleeve bearings are ten years old and most of the original bearings are in service, the oldest now having done more than 250,000 miles. They have always been used in waste packed heads and carefully lubricated at approximately one month intervals. Special long strand wool waste of the finest quality is used. A good sized plug of the waste is first laid on the bottom of the box directly under the bearing. Then a wick, made up of about three dozen of the wool strands which are at least 15 inches long, is laid over the shaft and bearings, extending down to the bottom of the oil well. The box is then packed full of the waste so that the oil can feed to the bearing at all times. The pressure of the spongy waste strands serves to hold the wick in place as well as help carry the oil to the bearing. The wool does not glaze as cotton does and the box runs for long periods of time delivering plenty of oil to the bearing. As the box covers fit snugly, water and dirt are excluded and



Two of the Special Jacks Used in Connection With Generator Work

the waste does not have to be disturbed during the interval to the next shopping of the car, nor is there any trouble due to water in the oil well.

Even with the long life obtained from these bearings, they are not considered as satisfactory or economical as ball bearings. The lubrication at monthly intervals is all right as long as the cars average around one hundred miles per day, but if they are used in emergency on long runs of a couple of hundred miles, as occasionally happens, just before they are due for periodical oiling, a hot box may develop. The oil cannot be confined to the box entirely and some gets into the machine and on coils, armature and brush rig, necessitating the use of kerosene to wash it out. The sleeve bearing is not as economical as the ball bearing because of the labor charge for monthly oiling and cleaning dirty generator interiors. Longer time is spent in cleaning the exterior of accumulated dirt due to the oil which spills over when the oiling is done or which works its way past the felt gasket in service.

The ball bearing life cannot at present be figured. Hundreds of bearings are ten years old now and show practically no wear, after their service record of approximately 250,000 miles. These bearings are removed with the aid of a jack made for the purpose. They are washed in kerosene to remove the free grease and then placed under a low pressure steam jet which quickly loosens all the hardened grease or scale found on the parts of the races not in actual contact with the balls. This steam bath cleans off the grease and as the bearing seldom attains a temperature as high as 150 degrees F. it is not

detrimental. Soda has been used to cut the grease but it is neither as quick nor simple as steam which is available in so many places. After steaming, the bearing while still warm is shaken to throw off the beads of water and the remaining moisture quickly evaporates off the warm surfaces, which become thoroughly dry in a very short time. The bearings are then filled with grease which is rubbed into the space between balls and races as well as over the entire exterior. No trouble from rust or corrosion has been encountered at any time as a result of this treatment. While the bearing is drying it is spun as rapidly as possible with the inner race held in the hand. If there are any bad balls or raceways they are discovered by this method as a very slight imperfection is sufficient to interfere with the smooth rolling of the balls, and the hand is sufficiently sensitive to detect the friction or jerky motion of the race if a defect exists. If the bearing is one in which the balls are enclosed entirely by the separator, as is the case with the older Hess-Bright bearing, this rolling in the hand is a very good test by which a fault may be detected.

If a bearing rolls unevenly when testing in this manner, it is laid aside for more detailed inspection with the aid of a search lamp. Occasionally a piece of foreign matter, a defective race or ball is found after the separator has been removed. These defective bearings are shipped to one of the companies doing rejuvenating and repairing who will return the same bearing, after repair if desired. The repaired bearings have always been satisfactory and the saving is worth while. Less than a dozen defective bearings are removed per year.

One feature that is carefully watched in regard to the bearing is the shaft fit. When the bearing is removed, if it comes off easily, it is always necessary to inspect the shaft to determine whether there is evidence of any wear. This is a very critical point for if there is the slightest wear at this point it is not very long until the shaft is pounded down sufficiently to let the armature strike the poles and the whole interior of the machine may be wrecked. If wear of the shaft is evident the bearing is tried on a new shaft to determine if there is any wear of the inner race, although this race rarely wears. Cases of trouble from the foregoing are seldom encountered but are carefully guarded against because of the extent of the damage they may cause.

This particular feature of removing the bearing is receiving a great deal of attention just now, owing to a few loose bearings having developed. The removal of the pulley end bearing for cleaning is thought to have something to do with the loosening of the fit although great care is exercised to remove and replace it without distorting the seat by cocking the race during the process. No trouble is experienced with the front end bearing but is confined to the back end. Experiments are being made to determine if the bearings can be properly cleaned and tested without removal from the shaft. All the trouble cannot be laid to disturbing the bearing as one of two cases have developed on generators which have not previously been overhauled and therefore, have not had the bearing disturbed since the original application.

Other Generator Parts

It is seldom found necessary to remove the armature entirely from the frame. When the back head is removed and the bearings taken off, the armature may be pulled out sufficiently to inspect it for defects in the banding wires, conductors or laminations. From the commutator chamber the condition of the commutator brush holders, brushes and other parts may be determined as the hand search lamp illuminates the whole interior.

If the field coils are dirty or oily, of course, the armature has to be removed entirely so that the interior may be cleaned. The dirt or oil is removed and the interior blown out, but no paint or shellac is ever used on the coils. It is desirable to radiate the heat from the interior of the machine as rapidly as possible and the use of any additional paint or coating only slows up the radiation and is of no particular value in preventing trouble from oil or dirt. A properly lubricated ball-bearing machine seldom has any dirt inside to speak of and in ten years of service not one case of a defective field coil has occurred. This is partly due to the fact that new and properly fitting felt gaskets are applied if there is any evidence of grease finding its way by the gasket. Gaskets are cheap and serve a very important purpose and are removed if there is any question of not doing their work.

Having finished the various other details of generator overhauling and rung out for grounds, the pulleys and suspension come in for attention. A recrowned armature pulley is applied if required, and the axle pulley checked for position, looseness on the axle, proper closing of the seams, flat spots, etc.

Most repairs to suspension consist of renewal of small parts such as bushings, etc., to stop rattles, rather than because of actual wear, although some of the oldest suspensions are beginning to require considerable renewals on account of wear. It is also necessary to replace some parts to bring the suspension back to the original position and allow for later alignment of the pulleys as wear occurs in service. Careful examination of the side hangers and suspension links is made to determine if there are any cracks or badly worn parts that might make them unsafe to run. All the weight is carried on these parts and breakage may cause a generator to fall to the track with disastrous results.

The overhauling having been completed, the generator is ready for final motoring as soon as the regulator overhauling has been completed. The work on the "downstairs" part of the equipment takes from three to four hours depending on the condition of the apparatus.

Pinkey, the Wire Curler

WELL boys, here goes nothin'. I am not going to be like our old car-lighting adviser, Hinkey Dee, and tell you all you don't know about everything and that nobody else knows anything, but instead I am going to tell you all about nothin' and claim I know everything about it. Hinkey Dee knows more than everybody about everything but he don't know nothin', and the fact I do know nothin' makes me the wiser of the two. That's logical, you'll have to agree.

Of course, I'll have to be satisfied with the brown derby and the leather garters because Hinkey Dee and his mate, Skoop Ramp, have a corner on the high hats; and another thing my seniority don't date back far enough.

You fellows, that think Hinkey Dee is his right name, are all wrong and laboring under false impressions; that's only his magazine name. He knows everything there

is to know about everything, but I want to get you off on the right track so you won't miss nothin'. I know his right name but I won't tell you because, in spite of all he "nose," he don't crave publicity. One more wise crack out of him though and his name won't be Hinkey Dee, because I'll tell the world who he is.

His recent discovery of T. C. electricity————————; well let's not dis-cuss it because it has been cussed enough. But anyway, why should so great a man go unheralded? Think of what an advantage it would be to society and the world in general, if other great scientists could meet and advise with him.

So now you see we know who he is, but he don't know who I am. I hated to do it, but my desire to tell you all about nothin' got the best of me.

I think you will all agree with me that it would be only fitting, if we should all doff our headgears and stand at attention for one minute in silent tribute to so great a man. All together now, let's go.

(One minute later.) Well, now that we got that off our chests, I am going to tell you some more about nothin'. If a fellow don't know nothin', he must at least know somethin' (get behind me, it's deep) especially when wise men like Hinkey Dee tell us everything. I don't claim I don't know nothin', but instead I do know nothin', which makes me know nothin'. There's more logic. I am analyzing the situation in such a way that you will be able to distinguish between everything and nothin'. Otherwise, you wouldn't know the difference between Hinkey Dee and me.

If you can't see my point, I'm sorry, because I certainly have made it plain. I know nothin' and if you fellows don't know nothin', you had better start studying up on it. You fellows that know everything and can't see through nothin', are dumb and don't know it.

I am not going to be like Hinkey Dee and keep you guessing who I am, but instead I will introduce myself. I am not going to reveal my right name, because, if I did, the U. S. mails would be like a Christmas rush the year 'round, there would be so many people, who know everything but don't know nothin', writing to me for data on the subject that you can readily see it would be the wrong thing to do. I can see myself being called on for papers to be read before all the different conventions and organizations, and can even forsee volumes to be writted for all the schools, colleges and libraries. Nothin', which is new and right, is always in great demand because nobody knows all about nothin'. And besides there are scores of people aching to find out where I am.

So to make a long story short, I am Pinkey the Wirecurler. That's the nic-name I go by in the railroad yard where I get my paycheck. I have never taken time to dope out the Wirecurler part of it, but I have thought about the Pinkey part and have arrived at the conclusion they call me that becaue of the light-red hue of my beard. Some time when I am not so busy telling all I know about nothin', I will go in study on the Wirecurler part. If you think I curl wire for a livelihood, you're wrong, because I don't; and what's more, I'm no good at marcelling. I am awfully good at solving deep and complicated problems; it's just a question of getting time enough to go into the matter.

Of course I have another name when I'm up-town, but it wouldn't do any good to divulge it because it don't have any bearing on nothin'.

Another thing, I'm a diplomat. I think it better to know all about nothin' instead of everything, and I don't believe in boring everybody with nothin', like these wizards that know everything and crow about it and can't tell you about nothin'. I'd rather know everything about nothin'; it's easier. To prove to you I am a diplomat and want to keep peace and good will among my readers, and to keep everybody from dropping their subscriptions to this magazine like a red-hot iron, I am going to ask you to phone the editor by letter, wire or radio whether you want me to write more about nothin'. He will advise me the result of your vote, in due course, with one letter. Otherwise, if each of you sent your ballot direct to me, Uncle Sam would run out of mail cars to handle the rush. And I don't want to have any more mail cars to put belts on; my helper is overworked now as it is. If you don't want any more of my counsel, it will please me, because I am awfully busy with my research work; and if you do, I'll have to drop that and then my counsel won't be so keen.

Did Hinkey Dee ever play that fair with you? No sir, you had to read his stuff or cancel your subscription, one of the two.

Built in 1882 by Brooks

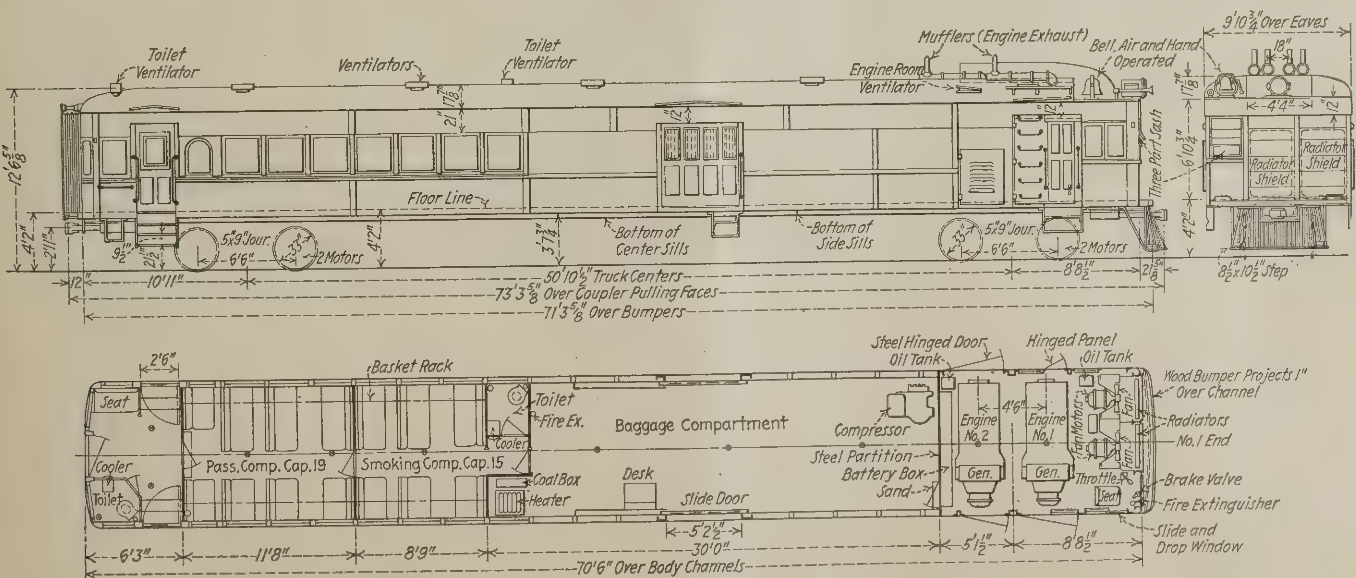
High Capacity Dual Power Plant Gas-Electric Car Built for the Seaboard Air Line by the Electro-Motive Company

Gas-Electric Cars for the Seaboard

Motor Equipment Permits Rapid Acceleration, High Speed Operation and Large Hauling Capacity

THE Electro-Motive Company, Cleveland, Ohio, has just completed the construction of a dual-power-plant gas-electric rail motor car which represents a distinct advance in the development of this type of car. In the general construction of the mechanical and electrical features this latest car is in reality a two-unit car, each unit of which is practically identical with the single units embodied in 37 other cars built by this company during the past year.

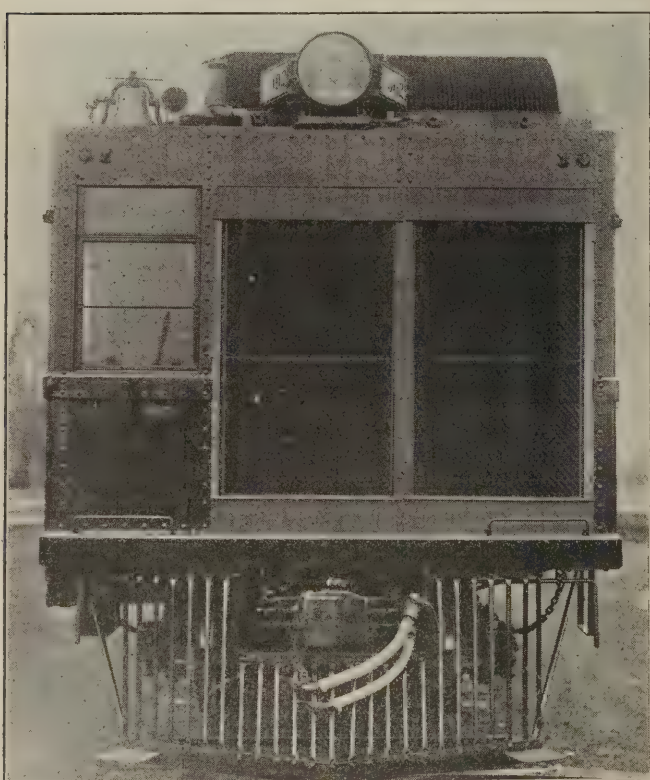
This new unit is the first of two being built at the plant of the St. Louis Car Company for the Seaboard Air Line and it was designed to handle a class of traffic peculiar to the operating conditions at certain points on that road. The Seaboard Air Line has for many years operated several high-class through trains to accommodate Florida-bound passenger traffic during the winter season. Quite often conditions necessitate the stopping of these trains at other than the most important stations to pick up passengers or cars at intermediate points. In the selection of a rail motor car to relieve this condition it was



Floor Plan and Elevation of the Seaboard Air Line High Power Car

desired to obtain a car of sufficient hauling capacity to handle one or two cars, such as chair or sleeping cars, or a greater number of lighter cars. The motor car is designed to handle cars and passengers from intermediate main-line or branch-line stations to main-line through-train stops. Such an operation in many cases man involve a motor car movement of only 50 or 60 car miles, after which the motor car, operating either independently or with trailers, will be used in local passenger or mixed service.

The unit described and illustrated in this article is the result of the demand for such a car and while designed, in this case, particularly for the operating conditions outlined above, it is also well adapted to high-speed operation on fast schedules between important centers where the nature of the traffic is such that the motor bus has been able to take away from the railroad a volume of traffic which the railroads have heretofore been obliged to handle

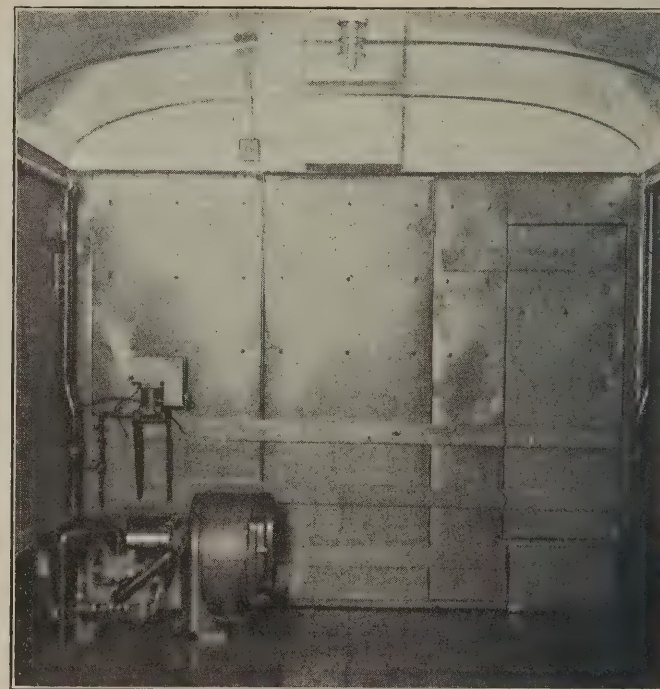


Front View Showing the Dual Radiator Arrangement

at a loss or not handle at all. One of the cars will be placed in service between Portsmouth, Va., and Lewiston, N. C.; the other will be used between Atlanta, Ga., and Abbeyville, S. C.

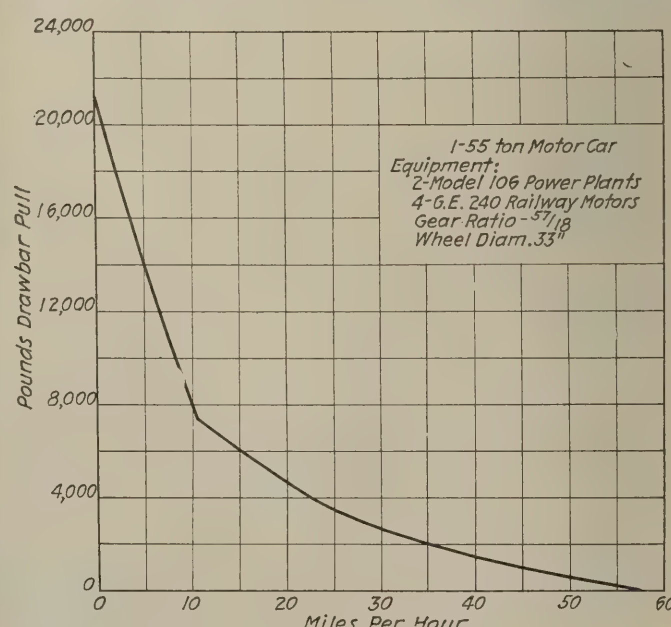
Mechanical and Electrical Features

The power is generated by two six-cylinder 200-hp. Winton gasoline engines direct connected to General Electric 700-volt direct-current generators. Whereas, in the single unit car the driving motors are geared to the two axles of the forward truck only, this latter car is in effect two separate units, one generator set furnishing the current for two driving motors on the forward truck, while the second generator set furnishes the current for two identical motors on the rear truck. The two units may be operated independently or together as operating conditions may require. This car is of the single-end control type and the controls are similar to those of the single unit cars. Three methods are provided for starting the engines: an electric starting motor and Bendix drive; a compressed air starter, and hand cranking. The engines



The Air Compressor Unit Is Located Above the Floor in the Front End of the Baggage Room—The Partition Is Divided and Hinged to Permit Access to the Power Plants for Maintenance

may be controlled separately or together by means of a locomotive type throttle. They are designed for normal operation at 1,000 r. p. m. at which speed the generators deliver approximately a constant power output under



Drawbar Pull Characteristic Curve of the Seaboard High Power Motor Car

varying operating conditions. The electric controllers are arranged for the independent operation of the forward and rear truck driving motors. The air braking equipment is Westinghouse type AML with automatic features.

The total weight of the car is 110,000 lb. and the total length is 70 ft. 6 in. over bumper channels with a width over the eaves of 9 ft. 10¾ in. The car body is made up of four compartments: the engine, baggage and passenger compartments, and the rear vestibule. The length of the engine compartment is 13 ft. 10 in.; of the baggage compartment, 30 ft. 0 in., and of the passenger compartment, 20 ft. 5 in. The baggage capacity is 20,000 lb., and the passenger compartment has a seating capacity of 34 persons.

The car is equipped with Hyatt roller bearings and will haul two standard railway cars, also roller bearing equipped. The other motor car and its trailers will be provided with standard A. R. A. journal boxes and brasses throughout. After these two trains have been in service for a certain period in which the power consumption on each will have been accurately measured by means of watt-hour meters, they will be interchanged, each having the former run and crew of the other, and the power consumption will again be measured. It is hoped in this way to eliminate all essential variables save the type of bearing, and, with due consideration of weather conditions, thus obtain an accurate measure of the performance of roller bearings as compared with standard railway journal bearings.

Single and Double Unit Cars Compared

A comparison of the operating characteristics of the single-unit and double-unit cars reveals the greatly increased hauling capacity at higher speeds. The acceleration, even under load, is rapid. A comparison of the acceleration of the single-unit and double-unit cars, operated without trailers, on a 0.5 per cent grade, shows that of the former to be 190 sec. from rest to 40 miles an hour, and of the latter, 73 seconds for the same speed range.

Under favorable grade and curve conditions maximum speeds of 45 to 50 miles an hour are possible with this car handling the maximum number of trailers. Rapid acceleration and a braking deceleration of 1.5 miles per hour per second render high speed operation, even with frequent stops, possible.

Due to the difference in accounting methods on different roads, it is difficult to give an exact figure on the cost of operation per car-mile. A conservative estimate, however, places this at from 50 to 60 cents.

The first of the two cars for the Seaboard Air Line left St. Louis, Mo., January 14, being routed under its own power over the Big Four to Cincinnati, Ohio, and thence via the Chesapeake & Ohio to Richmond, Va., the point of delivery. A speed of 60 miles an hour was readily attained on the demonstration run to Cincinnati with a single 36-ton standard coach coupled behind as a trailer.

Forty railroad mechanical and operating officers rode part or all of the way on this demonstration run which was made without mishap on a regular passenger train schedule.

Oil Electric Locomotive Tested on the Long Island R. R.

THE first 100-ton oil-electric locomotive, built for the Long Island Railroad by the Ingersoll-Rand, American Locomotive and General Electric Companies, was given a thorough test on the tracks at Erie, Pa., on December 1, 1925, before a gathering of representatives of numerous railroads.

The tests included the hauling of a train of loaded gondola coal cars and an observation car, a trailing load of more than 1200 tons. Switching operations were also conducted. While handling the entire train, it was started from the foot of the grade and also from the center of the grade. In another test, five of the loaded cars were hauled with two cylinders of one of the engines cut out.

A 100-Ton Diesel Electric Locomotive Recently Completed for the Long Island

The United States Civil Service Commission announces the following open competitive examination: Associate Electrical Engineer $3,000, Assistant Electrical Engineer $2,400. Receipt of applications for these positions will close April 30. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the post office or custom house, any city.

Test Board for Train Lighting Shop

Construction Details of a Circuit Switching Device Which the Southern Pacific Has Found Useful

By N. Hansen

Assistant Foreman Electrician, Southern Pacific Ry., Oakland, Cal.

THE Southern Pacific Company's main electrical shop for the repairing of all types of train lighting equipment is located in its passenger yards at West Oakland, California. It is situated on the second floor of the two story train lighting building. The battery room and battery charging plant occupy the ground floor. Axle generator and headlight armatures and other train lighting material of nearly every description are sent here for repairs from all over the Pacific System, the main lines of which extend from Portland, Oregon, south to San Francisco and Los Angeles then east to El Paso, Texas, and north east to Tucumcari, New Mexico, also east from San Francisco to Ogden, Utah.

The repair shop which is under the direct supervision of the writer is fairly well equipped to handle this work. Practically all of the shop equipment with the exception of three lathes and two drill presses has been designed especially for this work and most of it is built right in the shop. A number of these shop machines or devices will be subsequently described.

Fig. 1 shows a photograph of the shop test board which is an indispensable piece of apparatus and serves its purpose very well. It provides various voltages and currents both alternating and direct with means of quickly making connections to regulate and measure them when it is desired to test out any piece of apparatus. It stands 7 ft. 6 in. high over-all above the floor and is 48 inches wide and made of slate 1½ in. thick. A shelf 14 in. wide by 48 in. long is mounted at the base of the board 36 in. above the floor. This shelf has proved very convenient for holding portable meters, small apparatus to be tested, tools, etc.

Fig. 2 shows a wiring diagram of the test board. Switches 1, 2 and 3 are General Electric Company 200-ampere, 250-volt d.c. double pole, double throw knife switches. Switch 4 is the same capacity and make but it is a three pole, double throw switch. Switches 5 and 6 are 30-ampere, 250-volt d.c. double pole, single throw General Electric Company knife switches. Switch 7 is the same as 5 and 6 except that it is a double throw switch. Meter 8 is a Weston switchboard type, back connected direct current voltmeter, 9½ in. diameter base, with a scale of 0 to 150 volts. Meter 9 is a Weston switchboard type, back connected, direct current ammeter, 9½ in. diameter base, with a 100 to 0 to 100 ampere scale and external shunt. Lamp bank 10 consists of nine 50-watt, 120-volt carbon lamps mounted in No. 50723 General Electric Company keyless wall receptacles and all connected in multiple. Lamp bank 11 consists of five 120-watt, 220-volt carbon lamps also mounted in No. 50723 receptacles and connected in multiple. Numbers 12 to 18 inclusive indicate pairs of plug receptacles and 19 three receptacles. These are made of brass 3¾ in. long and 1 in. outside diameter except for the 1⅜ in. diameter x ¼ in. shoulder which rests against the front of the board. The part projecting through the board is threaded all the way with a 1 in-12 thread to accommodate a locknut and nuts to secure the cable lugs. The hole in the center is 3 in. deep reamed to a ⅝ in. to the foot taper with a 23/32 in. opening. The plugs which are fastened on the jumper and other cables used to plug in on the board are likewise made of brass, the ends being tapered to fit the taper of the receptacles. The tapered part of the plugs is 3 in. long, 2 in. of which fits into the receptacle, the other 1 in. has a 3/16 in. hole drilled

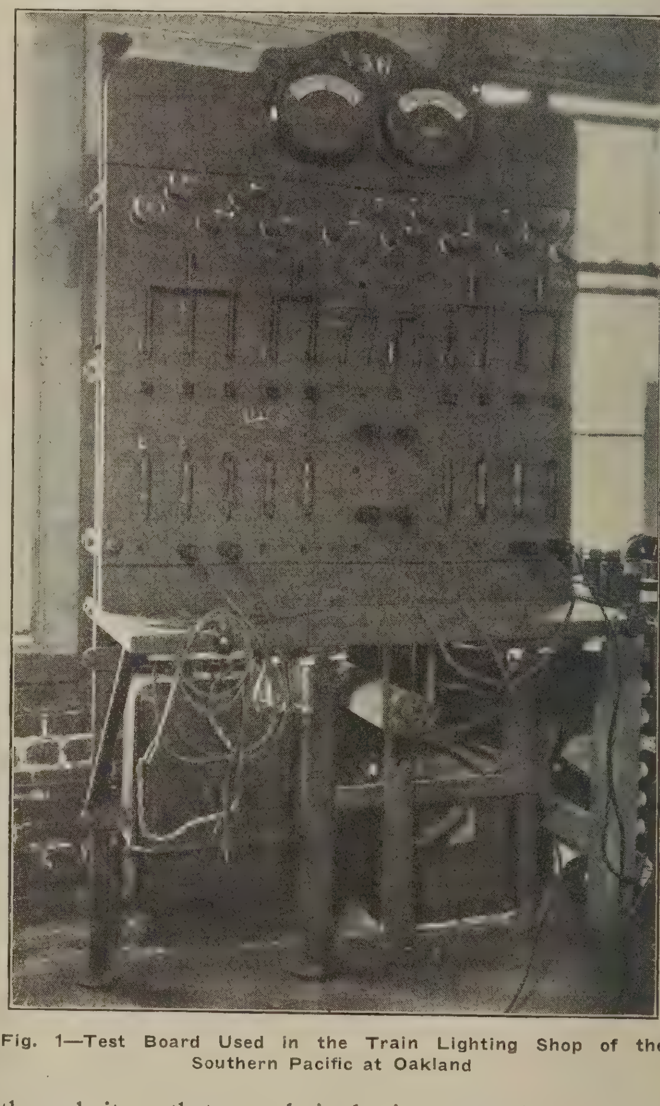


Fig. 1—Test Board Used in the Train Lighting Shop of the Southern Pacific at Oakland

through it so that any desired wire connections may be made to it by means of a No. 10 machine screw and nut. The cable 4 extra flexible, rubber covered, is sweated in the ends of the plugs inside a hard wood handle 4½ in. long by 1½ in. diameter. There are two switchboard jumper cables, 45 in. long overall and two jumpers, 60 in. overall with one of these plugs on both ends of each, also two eight foot cables with a plug on one end of each and

a special lug on the other end of each to connect to the terminals of the armature testing stand. The latter cables and two of the jumpers are shown in Fig. 1. on the right hand side plugged in the board supplying 32-volt battery current from the positive or right hand receptacle to the ammeter testing stand (not shown), then back to the ammeter receptacle, through the ammeter shunt, then through the carbon pile rheostat and back to the negative side of the line. Three 50-ft. cables of 6 extra flexible,

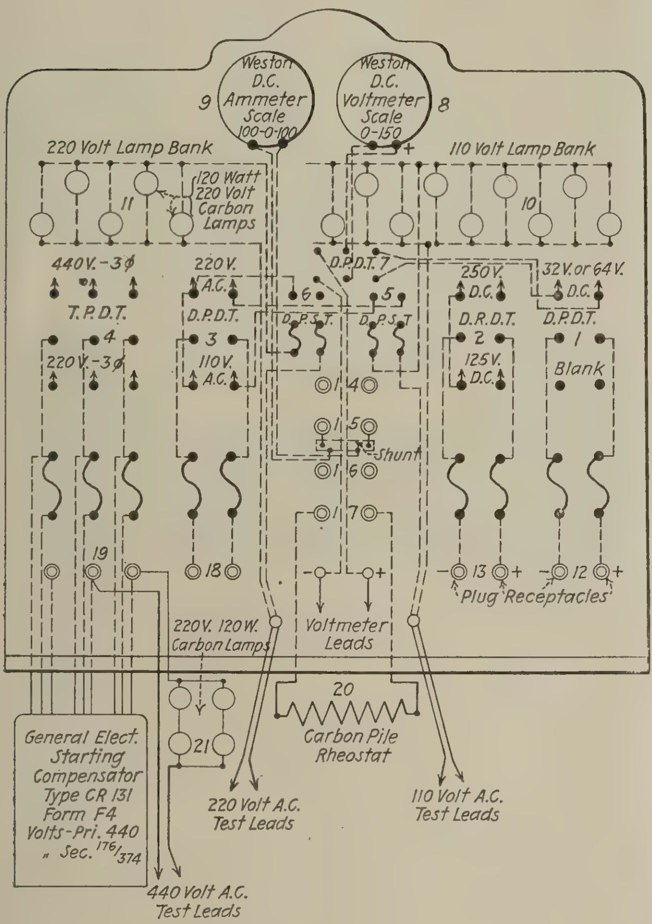


Fig. 2—Wiring Diagram of Test Board

rubber covered wire with a plug on one end of each also belong to the board. These are used to run to a motor or other heavy piece of apparatus which is not convenient to move close up to the board. There are also two three-foot cables with a plug, one end of each shown on the left hand side of Fig. 1 plugged into two of the No. 19 receptacles. These are used temporarily to bring the 440-volt current to the lamp bank 21, Fig. 2, located under the shelf. This bank consists of four 120-watt, 220 volt carbon lamps connected up in series-parallel, the whole bank being in series with a pair of test leads, used when testing 32-volt armatures for grounds.

The carbon pile rheostat 20, Fig. 2, shown under the shelf in the middle in Fig. 1 is connected to receptacles 17. It is made up of 18 inches of U. S. L. cat. No. 11064 carbon discs 3/16 in. thick by 2¾ in. diameter with two No. 11116 thrust plates on the ends. These carbons are set in a trough 20½ in. long, 2 13/16 in. wide by 1½ in. deep made out of ⅝ in. Transite board. Current from 5 to 75 amperes is regulated by this rheostat. It is used principally when supplying current at 32 volts to armatures in the armature testing stand when making the bar to bar drop test or when trying to locate a ground in an armature by passing a heavy current through the commutator to ground when ordinary methods fail to locate it.

The upper clips of switch 1, Fig. 2, are connected to either a 32-volt or 64-volt set of batteries whichever is desired (usually the 32 volt) located in the battery room down stairs and connected up to the test board through the switchboard in the battery charging plant.

The lower set of clips on this switch are blank, but were originally intended to be permanently connected to a 32-volt set of batteries and the upper clips to a 64-volt set. This was found to be impractical on account of the batteries continually moving in and out of the battery room. By means of a call bell and speaking tube located in the foreman's office it is but a few minutes' work to instruct the battery man and get a set changed.

Switch 2 is supplied by a 250/125-volt d.c., three wire line from the motor-generator set in the battery charging plant. These voltages are used in testing out any direct current apparatus of corresponding voltages.

Switch 3 is supplied by a 230/115 volt, 60 cycle, single phase, three wire a.c. line from the lighting transformers which in turn supplies switches 5 and 6 controlling lamp banks 10 and 11. These voltages are also used when supplying current to 110-volt, 64-volt or 32-volt lamps which are to be dipped red, green, etc., by running a temporary line to the lamp dipping stand with two of the 50-ft. cables previously spoken of.

Switch 4 is supplied by a 440-volt, 3 phase, 60 cycle, three wire line to the top clips and by a 220-volt, 3 phase, 60 cycle, three wire line to the bottom clips. A type CR 131 Form F4-440 volt, General Electric Company starting compensator is permanently connected up to this switch and its fuses, so that a three phase motor can be plugged into receptacles 19 and started right up. One phase of the 440-volts as already stated is used for making ground tests on 32-volt armatures.

Switch 5 controls the 110-volt lamp bank 10 which is in series with a pair of test leads, shown in Fig. 1 coming through a bushing in the board just above and a little to the right of the rheostat. These are used for general circuit testing.

Switch 6 controls the 220-volt lamp bank 11 which is also connected in series to a pair of test leads shown in Fig. 1 coming through a bushing in the board just to the left of the 110-volt leads. These are generally used when testing out commutators for shorts between bars before winding the armatures and for any other general purpose desired.

The 110-volt, 220-volt, and 440-volt test leads are each made from No. 14 green cotton, twisted lamp cord about 8 feet long. The ends of each lead are soldered to twenty penny nails with the heads cut off. These are then protected by a piece of rubber tubing extending to about 1 inch from the ends of the nails.

Switch 7 normally is kept closed in the right hand position so that voltmeter 8 always registers the voltage of the set of batteries connected up to switch 1. These batteries are used more or less all day long and when they get too low another set is connected up. When switch 7 is thrown to the left it is connected up with two voltmeter leads which come through two bushings in the board just below receptacles 17. These leads are No. 18 single cot-

ton lamp cord about 6 feet long and have a Frankel test clip on the end of each. In order that these leads will not be in the way when not in use, a small weighted pulley pulls them down in the two 2½ in. pipes shown below the center of the board, one on each side of the rheostat. These two vertical pipes stand 37 in. high and are secured to the floor by a floor flange with lag screws. When connected to these leads the voltmeter is used for all purposes which its range and type will permit such as taking the drop on field coils, solenoid coils, etc. Receptacles 14 and 16 are blank.

The two batteries seen on the floor behind the switchboard in Fig. 1 are old 180-a.h. iron clad 6-volt Exide batteries formerly used on locomotives. They are now used on a local yard telephone system for the train lighting yard men only. They also supply current to a solenoid operated air whistle valve used for calling the yard electricians and battery men each of whom answers to a different whistle call. Push buttons located in the shop and charging plant are used to operate the whistle. When called, the men ring in the charging plant from the nearest phone and are answered by the operator of the plant over the local phones. A number of phones are located at convenient points in the yard. This system saves much time and useless walking.

Experiments Determine the Adaptability of Electric Arc Welding

By A. G. Bissell

General Engineering Department, Westinghause Electric and Manufacturing Company

An interesting application of arc welding in the erection of a structural steel building was recently made at Eola, Ill., where the Chicago, Burlington and Quincy Railroad erected a 60 ft. by 40 ft. one-story mill-type building, using scrap steel. An exact duplicate of this building was also constructed by the riveted method. Data furnished by W. T. Krausch, engineer of buildings of the railroad company, shows the following comparison in erection costs:

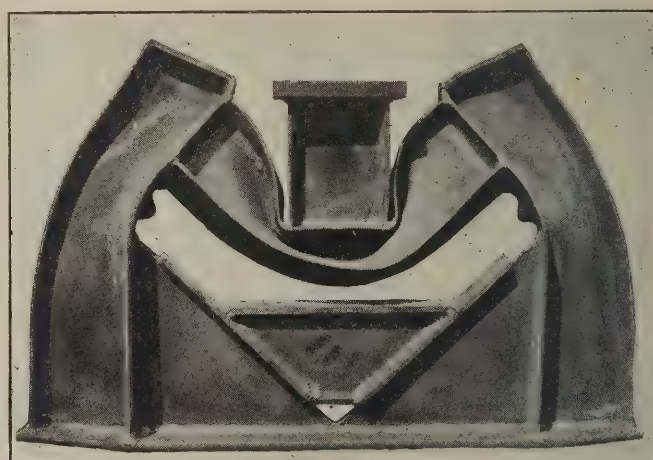
	Arc Welded	Riveted
Preparation cost, including material and shop fabrication	$381.71	$1,000.50
Field erection cost	404.49	339.00
	$786.20	$1,339.50

It will be noted that the saving in favor of the arc welded building lies in the minimum of preparation required—merely the cutting of the steel to required length. No clip angles, gusset plates or butt straps are necessary, while besides these, the riveted job involved shop details and layout, punching, painting, reaming and shop fabrication. In the riveted structure 27,100 pounds of steel were used, while but 25,619 pounds were used in the welded structure—a reduction of 5½ per cent in favor of the welded type of construction. The saving in steel and reduction in total erection cost in this case resulted in a final saving of 41.3 per cent where arc welding was used in place of riveting.

Tests were made of welded joints for tensile, sheer, static, shock and fatigue strength of such joints, compared to similar joints made by riveting, and to the steel members welded together.

Using ½-in. and ⅜-in. plates beveled at 60 degrees and arc welded to form a butt joint as a section subjected to tensile strength tests, it was found that the joint in the ½-in. plate developed an average tensile strength of 64,400 pounds per sq. in., with an elongation of 4 per cent in a 1 inch section across the weld. The steel in which the joint was made had a tensile strength of between 65,000 and 70,000 pounds per sq. in., and failure in the piece occurred in both base and deposited metal. Welding wire used was hard-drawn mill-steel, having a carbon content of .17 per cent and a manganese content of .55 per cent.

In sheer test, a similar joint developed 50,550 pounds per sq. in. in sheer, and when subjected to static tests, a



Fabricated Test Specimen Shows How Members May Be Deformed Without Opening the Weld Seams at Any Point

pressure of 40 tons deformed the supporting beams completely, but failed to produce any evidence of failure in the welded joints. In fatigue test, a riveted and welded joint of similar design were mounted on a vibratory testing machine and subjected to a vibration or vertical movement of 1/16″ at the rate of 1760 complete cycles per minute. After 18 hours and 20 minutes, there was hardly a joint in the riveted member which was not thoroughly loosened, the rivets worn, the rivet-holes enlarged, and a number of portions broken off the main section. None of the arc welded portions were weakened or damaged, and it was necessary, in bringing about its destruction in a continuance of the test, to append weights to the outer ends of the riveted beams and arms. When finally the model failed, failure occurred in the beams and not in the welded joints. Under a sudden shock of 700 tons administered directly to an arc welded joint section, the welds did not fail, even though the structural steel members of the section were severely strained and deformed.

From the foregoing test results, the practicability and substantiality of electric arc welding in the fabrication of structural steel is evident. In no case did an arc welded joint fail prematurely nor before sections of the beams joined in the weld themselves failed.

Supplementary compensation, amounting to $1,367,426.07 was paid in February by the General Electric Company to 30,813 employes of its plants and offices who have been with the company for five years or more. The sum paid each individual represents five per cent of his earnings for the six months ending December 31, 1925.

Contractor's Work Train Equipment Used for Overhead Construction—The Auxiliary Messenger and Double Contact Wires Are Being Strung Together

Illinois Central Electrification Progress

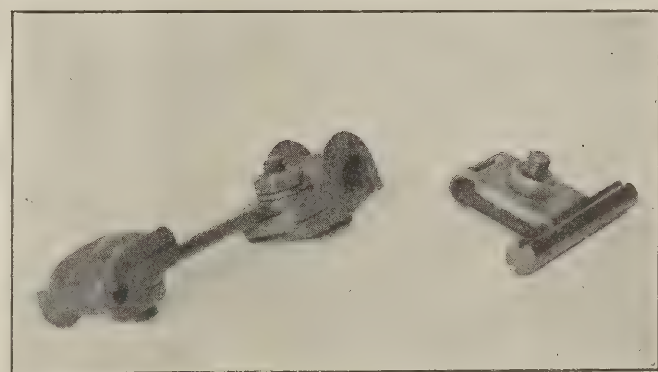
Construction of Overhead Distribution System is Now Well Under Way

THE overhead distribution system for part of the territory included in the electrification program of the Illinois Central is already completed and the remainder of the work is being pushed rapidly at the present time. That portion of the main line program be-

Where Signals Are Required, Combined Catenary and Signal Bridges Are Being Installed, Except Between Homewood, Ill., and Richton Where Existing Signal Bridges Have Been Utilized

tween 115th street and Richton, Ill., consisting of two main tracks, is nearly all completed, and in addition a substantial percentage of the catenary system on the Blue Island and South Chicago branches is finished. Traction power supply, as reported previously in these columns, will be at 1,500 volts d. c. from seven substations adjacent to the right-of-way, which are, in turn, fed directly from generating stations of the Commonwealth Edison Company or the Public Service Company of Northern Illinois, through whom the Edison Company is supplying power outside of the city limits of Chicago.

Without additional feeders the catenary system is so designed that it will in itself provide the necessary current carrying capacity. The catenary system over each main track comprises a composite copper and copper-clad steel



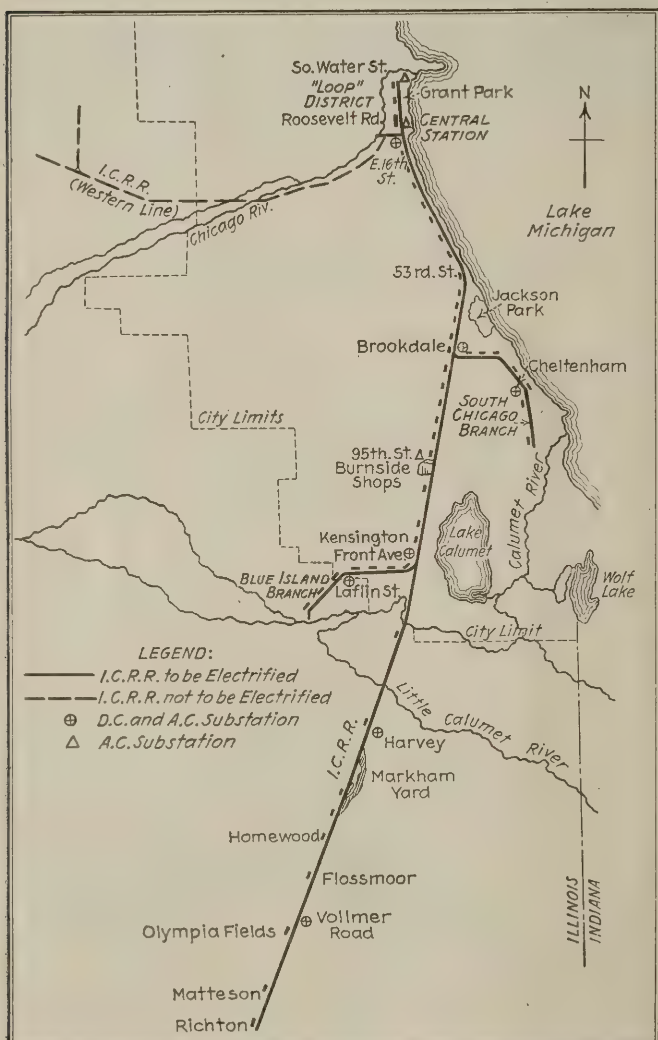
Catenary Hanger and Contact Wire Supporting Clamp

main messenger of high tensile strength, a hard drawn copper auxiliary messenger and two cadmium bronze or copper grooved contact wires. The latter are normally 22 ft. above the top of the rail south of 43rd street and will be 18½ ft. above the top of the rail north of 43rd street. In the heavy traffic section north of 67th street, No. 3/0 A. W. G. bronze contact wires will be used to obtain best wearing qualities, while on the remainder of the main line and on the South Chicago and Blue Island branches No. 4/0 copper contact wires are being used. Throughout the life of the contact wires the average con-

ductivity over each track will be approximately equivalent to 790,000 circular mils of copper. Nonferrous hangers and fittings are used exclusively. These hangers are all furnished on the job, cut exactly to the correct length.

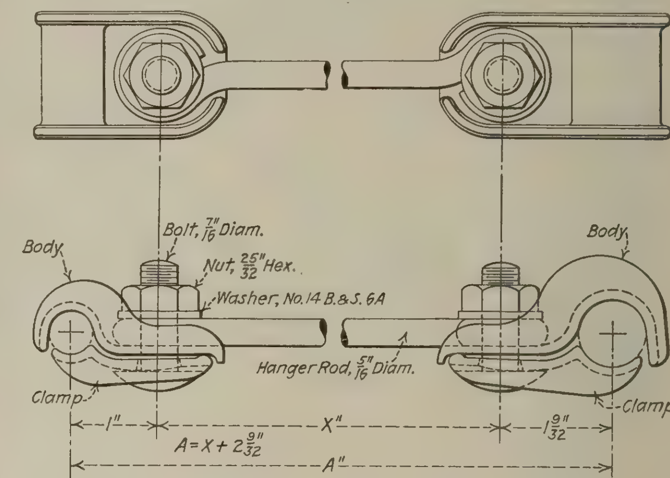
Construction Progresses Rapidly with Work Train Equipment

Work trains of several cars each are being used for the stringing of all overhead wires and for clipping-in and steady bracing all of the overhead system. Special platforms adjustable as to elevation have been built on flat cars to accommodate the necessary number of men to carry out most economically the clipping-in process. A reel car,



Outline Map of the District Included in the Illinois Central Chicago Terminal Improvement

tool car and required number of supply cars make up the remainder of the work train used by the contractor. The main messenger is the first wire to be strung over a section of track from the work train. In doing this the greatest part of the slack is taken up by the train itself, but the final tension for each reel length is obtained from a hand winch operated by two men on the train. They are able to read the tension directly from a spring scale, which, with the assistance of a very carefully prepared temperature tension chart, enables them to secure the proper tension accurately. To facilitate the operation of pulling the messenger and contact wires, pulleys are temporarily suspended from the insulators. One reel of cable is pulled up and anchored temporarily before any splice is made in messengers. On straight track this arrangement enables the stringing of about two to four



Catenary Hanger Assembly. Clamps, Bolts and Washers are Made of Bronze and the Hanger Rod is Hard Drawn Copper

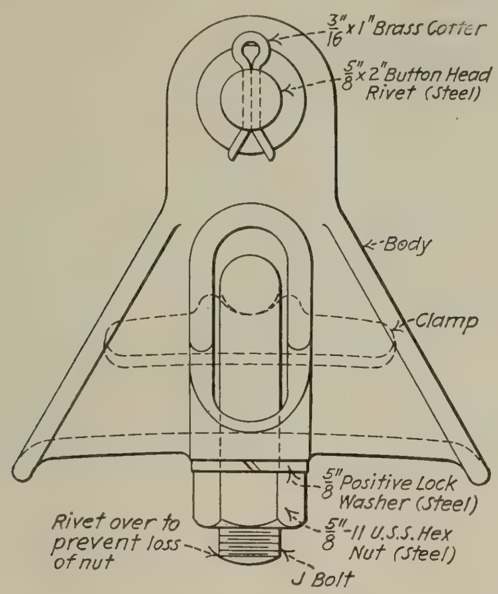
miles of main messenger in a day with a gang of eight linemen.

The next step in work train operation is the suspension of the hangers from the messenger. This is facilitated greatly by the tagging of hangers for each individual span.

Type of Single Column With Double Brackets Used in Double Track Territory South of Kensington (115th Street) Catenary Span Has Been Completed on Southbound Track, While That Over Northbound Track is Not Yet Clipped in

Following this operation the auxiliary messenger and double contact wires are strung together because it is just as easy to pull up three wires at a time as it is to handle them one at a time. Proper tension in the auxiliary messenger and contact wires is secured prior to clipping-in the hangers and fittings. Each wire of the double contact

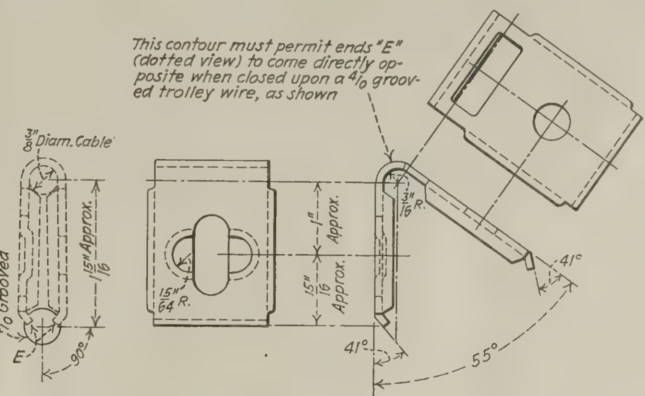
wire system is alternately clipped to the auxiliary messenger, making an extremely flexible overhead contact system, capable of making good contact with motor car pantographs with no visible sparking. Stringing of auxiliary messenger and contact wires is made at about the same



Suspension Clamp. Body and Clamp are Made of Bronze

rate as the erection of the main messenger, averaging about two to four miles a day. After the clipping-in work is finished on a section of catenary the next step is the

distribution line between 69th street and Harvey, the proposed point of steam-electric change-over for through passenger and freight electrification. In addition to the 3-phase lines there are duplicate single-phase 2,300-volt signal power lines installed on the same catenary structures. These lines will be sectionalized at each substation and connected to the power company's 12,000-volt, 3-phase system through transformers. At signal locations, distri-



Catenary Clamp Made for 3/32-in. Sheet Bronze

bution transformers are installed in duplicate, such that in the event of a power failure on the line used normally the signal load will be transferred automatically to the auxiliary line to insure continuity of signal service and non-interruption to traffic. All signal distribution lines will be served from the seven traction substations erected by the power company adjacent to the right-of-way, and in addi-

Existing Signal Bridges Have Been Used as Catenary Supports, Between Homewood, Ill., and Richton

tying-in of the wires with the steady bracing to effect correct alignment.

Catenary Structures Also Carry A. C. Distribution System

To feed the miscellaneous lighting and power load on the railroad right-of-way, 3-phase, 4-wire, 4,000/2,300 distribution lines are being installed on the catenary structures. There will be duplicate lines of this type north of 69th street, but initially a single line only is being installed in the territory south of 69th street to the end of the electrified zone at Richton. Plans provide a future additional

tion from sources of a. c. power at three other points. For a large part of the mileage the signal control cables are also carried on the catenary supports. On the South Chicago and Blue Island branches the overhead system will also carry the telephone cables.

For the entire project a total of 1,200 concrete foundations will be required for the steel overhead structures, each containing about 7½ cubic yards of concrete. These foundations are already installed on the main line, from 23rd street south as well as on the South Chicago and Blue Island lines.

Overhead steel supports for the catenary system are

spaced approximately 300 ft. apart. Single columns with double brackets extending out over the tracks are being used south of 115th street, and upon these provision is being made for the addition of trusses and columns, which will be used for the future electrification of freight and through passenger service to the proposed locomotive change-over at Harvey.

At locations south of 115th street (Kensington) where signals are required, combined catenary and signal bridges with built-up columns and trusses are being installed. North of Kensington, structures of built-up columns and trusses are being installed which will ultimately span the entire right-of-way, 200 ft. in width. With the exception of a few locations where work has been delayed because of track rearrangement, practically all catenary structures for the initial electrification were completed south of 31st street at the beginning of this year.

Change in Signaling System

The electrification of the suburban zone makes necessary the replacement of the d.c. automatic signals with a 60-cycle alternating current system. Principally it amounts to a change in track circuits for the present color-light signals will remain in service.

Between Homewood and Richton the signals are mounted on existing signal bridges, and on the South Chicago line are attached to the catenary columns, but on the main line north of Homewood they are suspended from combined signal and catenary structures.

Studies were made of car, engine, roadway and signal equipment and of train operating characteristics in order that the signals might be located to provide maximum carrying capacity. As an indication of the thoroughness with which this work was undertaken it should be stated that these elements included profile and alignment of the right-of-way, station locations, accelerating and braking rates, and the normal and maximum attainable speeds on various grades for all types of equipment to be operated as well as the visibility of the signals, the time required to change from one aspect to another, the comprehensiveness and comparative simplicity of the scheme of aspects displayed by the signals and the indications they convey.

Hell Gate Bridge, New York

Main Concourse, Chicago Union Station

Electrical Features of the Chicago Union Station*

Full Utilization of Present Day Electric Service Is Realized in Many of the Facilities Installed in This Modern Terminal

By C. W. Post,
Electrical Engineer, Chicago Union Station, Chicago

MANY kinds of electrical service and applications are found in the new Chicago Union Station. This new passenger terminal includes a high tension sub-station with its transforming and converting equipment, an underground distribution system, building lighting, street lighting, power for heating and motors, telephones, telegraph, telautograph, clocks, time stamps, time recorders, fire alarms, train lighting, battery charging and baggage and mail handling by electric trucks and tractors. It represents an expenditure for electrical equipment of $1,500,000.

Electrical Substation

Electric power for the entire project is supplied by the Commonwealth Edison Co., and rather an elaborate substation is required which is located in the sub-basement near the center of the headhouse. The electrical equipment for the substation, including its installation, cost approximately $165,000. A similar substation was installed in the mail terminal building at a cost of $133,600. The equipment was largely furnished by the Allis-Chalmers Mfg. Co., the General Electric Co., the Cutter Electrical & Mfg. Co., and the Conduit Electric & Mfg. Co., and was installed by the Hatfield Electric Co.

The electric power is supplied by three 3-phase, 60-cycle, 12,000-volt lines. One of these lines will eventually come direct from a generating station and the other two form a part of a loop connecting two or three other customers' substations, of which the mail building substation is one.

The 12,000-volt portion of the substation is in three distinct sections, separated by fire walls and doors, one line feeding each section. This will prevent any trouble occurring in one section from being communicated to the other sections. Spare units are provided for all services and the entire station can be operated from any two sections and a large part from any one section.

The structure in which the 12,000-volt equipment is installed is arranged to isolate the lines, busses and circuits as far as possible. Oil switches are installed in three separate rooms with concrete barriers between the switches. Type F-11 12,000-volt switches are used for the power company's lines and Type D-17 for the feeders.

The Commonwealth Edison Company's lines are connected to a separate bus from the feeder circuits. This bus is in three sections tied together with disconnecting switches. Metering current transformers are installed between the line bus and each of these feeder busses.

The feeders from the three feeder bus sections connect to the following:

Section No. 1—1—600 kva. 3-phase, 60-cycle transformer for rotary converter.

1—833 kva. 1-phase lighting transformer.
1—250 kva. 1-phase transformer for 2,300-volt service.

Section No. 2—1—600 kva. 3-phase, 60-cycle transformer for rotary converter.

*Abstract of paper presented before the Western Society of Engineers, Chicago.

1—833 kva. 1-phase lighting transformer.
1—250 kva. 3-phase transformer for fire pump.

Section No. 3—Same as No. 1.

It is estimated the maximum load will be as follows:

230 volts d.c. power	800 kw.
115/230 volts a.c. building lighting	800 kw.
2,300-volt service	200 kw.

The mail terminal substation has a maximum load as follows:

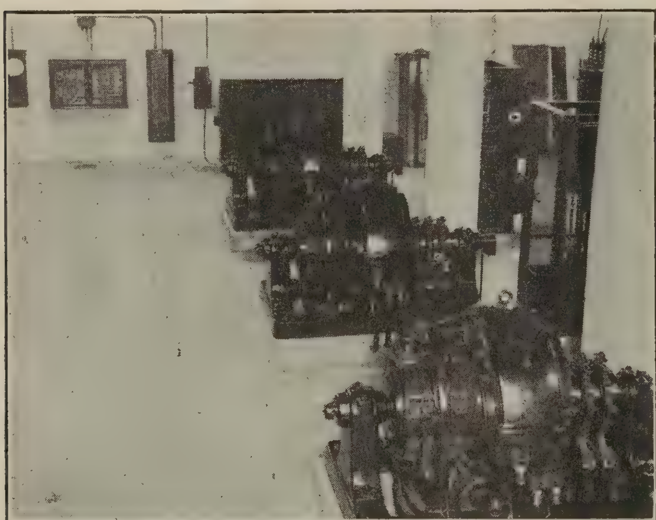
230 volts d.c. power	300 kw.
115/230 volts a.c. building lighting	450 kw.
440 volts a.c. power	150 kw.

This gives a combined load as follows:

230 volts d.c. power	1,100 kw.
115/230 volts a.c. building lighting	1,250 kw.
2,300-volt service	200 kw.
440 volts a.c. power	150 kw.
Total	2,700 kw.

The actual measured demand may not be this high since the peaks of the four services may not occur at the same time.

Consideration of speed control requirements of most of the motor applications in the main station led to the instal-



The Three Rotary Converters are Located in the Center of the Substation

lation of direct current equipment for power purposes. This equipment consists of three 50 kw., 230-volt Allis-Chalmers rotary converters. The d.c. side of these rotaries are connected to a common bus to which all power feeders are connected.

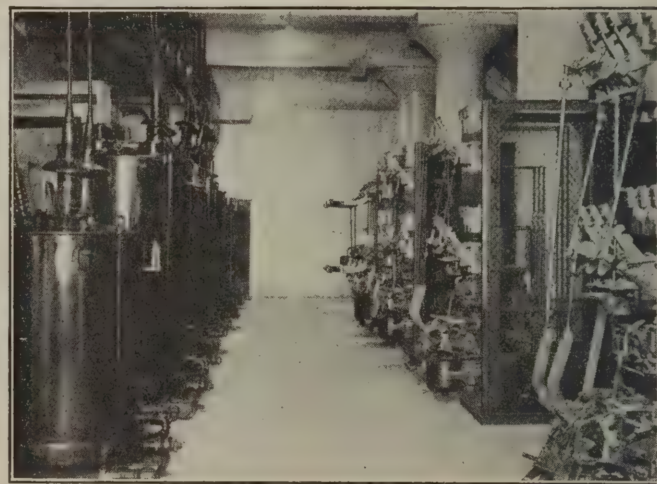
These machines, as well as the main switchboard, are raised above the floor level. The substation floor is the lowest part of the building and is 24 ft. below the river level. The drainage of the sub-basement is handled by two 500 gal. per min. bilge pumps driven by 15 hp. motors. This should be ample for any emergency, but the raising of the equipment above the floor was an additional precaution to prevent a shut-down on account of flooding the floor.

Lighting System

The lighting for the station is supplied by three 833 kva. single phase, 12,000/230-volt transformers connected to the three different phases of the 12,000-volt busses.

The secondaries of these transformers are controlled by 4,000-amp., Type—LG, Cutter motor-operated circuit breakers controlled from the main switchboard. There are four of these breakers mounted on two panels located between the transformers and the main switchboard.

These breakers are arranged in two rows; one in the top row controls transformer No. 1 and the other transformer No. 3. The two in the bottom row control transformer No. 2. On account of the transformers being connected to different phases they cannot be paralleled on the

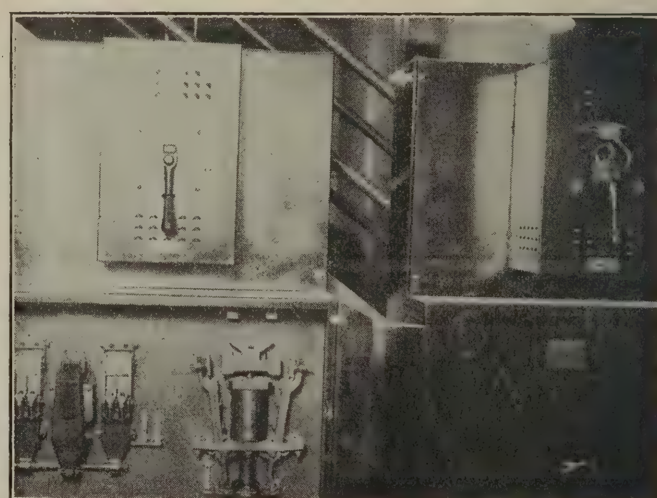


Transformers and Motor Operated Circuit Breakers in the North End of the Substation

low side and the breakers are mechanically and electrically interlocked to prevent this.

This condition made it necessary to install two separate lighting busses on rear of main switchboard. The lighting feeder circuits are arranged in three horizontal rows. The top row of feeders can be changed from one bus to the other as necessary to equalize the load on the two busses.

Oil circuit breakers were considered for this installation, but the decision was in favor of carbon break circuit



Automatic Starters for 50 Kw. Motor-Generator Sets in the Substation

breakers as they require much less space and permit a much neater and more economical bus arrangement.

Main Switchboard

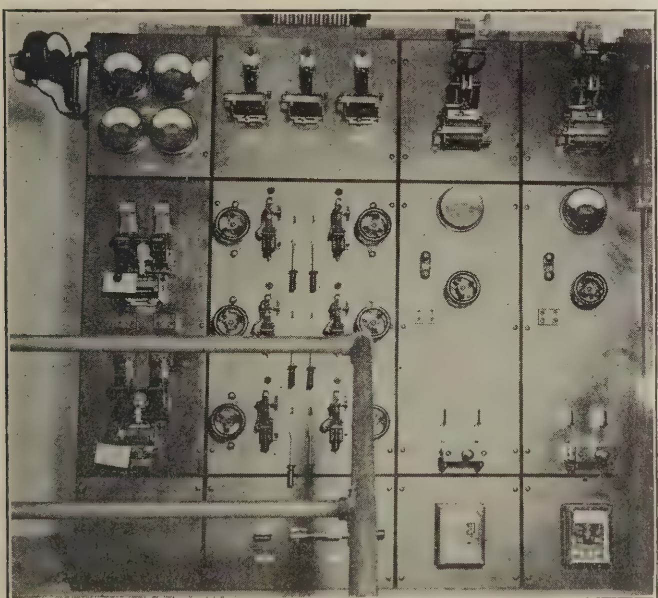
All high tension and low tension equipment is controlled from this board except the 2,300-volt service. The meters, relays and control for the power company's lines are lo-

cated on two panels at the right hand end of the board. The watt-hour meters, graphic meters and overload relays are mounted on this board. The equipment for lighting of trains and charging of car batteries is controlled from this board. There are also three blank panels for future lighting feeders to supply the 12 additional

Edison 12,000 Volt Cable Entrance and High Tension Bus Construction

floors, for which the building is designed. All light and power feeders are fed from this board.

Each feeder is connected to its bus through an I. T. E. circuit breaker which is non-closable on overload. In case the operator attempts to close a breaker on a feeder having a short circuit or an excessive overload, it will



Train Lighting and Train Battery Charging Panels of the Main Switchboard

trip free from the handle and cannot be forced into the closed position.

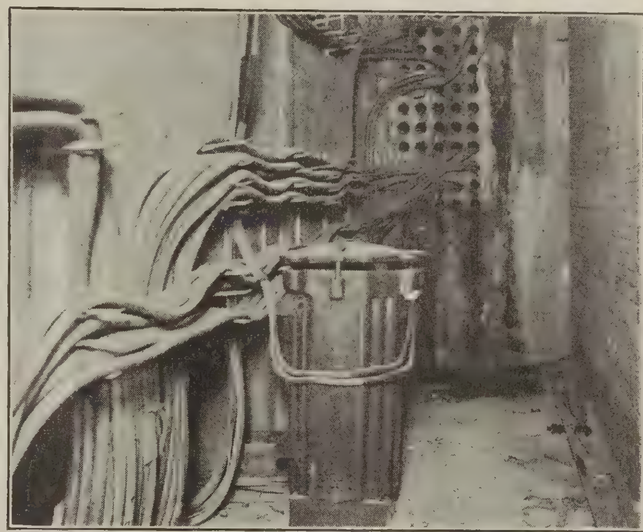
The lighting busses and feeders leaving the board are 2-wire, 230 volts. At the base of each riser shaft or point at which first tap is made an auto-transformer is installed. This is connected across the 230-volt feeder and the middle tap brought out for the neutral which is carried along with the outside legs to the end of this feeder, which provides 115/230-volt distribution. On account of the long feeder runs, this system effected a considerable saving in copper.

The cables on leaving the switchboard enter the underground duct system. These ducts run to the base of the risers at the four corners of the headhouse, also to the concourse and other distributing point.

All cables in the substation between transformers, rotary converters and switchboards are carried in iron conduit laid in the floor. All this cable as well as that in underground ducts is rubber insulated lead covered. All wire used throughout the building has 30 per cent rubber insulation.

The 2,300-Volt Switchboard

This board is supplied by two 250 kva. single phase transformers. The transformer secondaries and feeder circuits are controlled by G. E. FK-13 hand operated oil switches mounted on rear of board which was also built by the General Electric Company. The transformer



Cable Vault in Rear of Main Switchboard, Auto Transformer Shown is for the Emergency Lighting Circuit

switches are located at the center of the board and three feeder circuits on each side.

The two feeders for the interlocking system are in duplicate throughout feeding duplicate transformers at various locations along the tracks. The feeders for the street lighting and the trainshed lighting are connected to alternate lights. By this arrangement the failure of one feeder will affect alternate lights only, leaving one-half of the lights burning over the entire space.

Service for Train Lighting

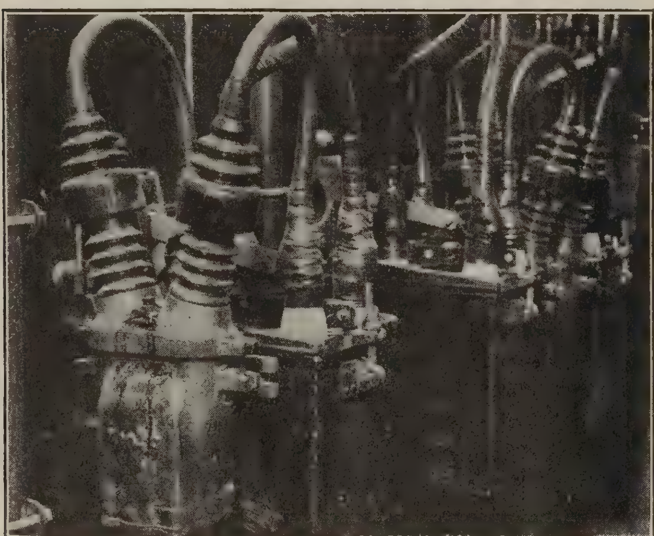
For train lighting service two 50 kw. Allis-Chalmers motor-generators are installed in the substation and controlled from the main switchboard. The motors are 230 volts d.c. The generators are designed to operate from 70 volts to 90 volts. The remote control starting panels for these sets were furnished by the Sundh Electric Co., and equipped with "Urelite" I.T.E. enclosed, externally operated circuit breakers.

Three classes of service are handled from this system. Some of the trains entering the station are lighted by a steam turbine driven generator in the baggage car using

steam from the locomotive. A train with head end lighting equipment, standing in the station without the locomotive, requires a 64-volt constant potential. For this service a receptacle is provided at each bumping post. Two circuits from this section of the main switchboard feed these receptacles.

The charging of batteries of axle lighted equipment is provided for by receptacles installed along the platforms for each track at intervals of approximately 250 ft. These receptacles for the southbound tracks are fed from a similar system in the mail terminal substation. Those for the northbound tracks are fed from this substation. Six circuits supply these receptacles through Allen Bradley rheostats and circuit breakers so that any desired charging rate can be supplied. Reverse current features prevent discharge of battery in case of power failure.

These circuits are normally dead. If a car inspector wants to charge a battery he calls the substation from telephones located on platforms, giving him the receptacle number, battery voltage and rate desired. The operator then energizes the proper circuit and adjusts the charging



Rear View of 2,300 Volt Board Showing Oil Switches and Disconnecting Pot-Heads on Feeder Cables

rate by the carbon compression rheostats to the desired current.

Motor and Control Equipment

The demand for a wide range of speed for a large percentage of the motors determined the installation of a direct current power system. The control equipment was manufactured by the Sundh Electric Co., and comprises a variety of types. There are automatic, remote control and hand starters. All starters are enclosed in steel cabinets. Hand starters under 25 hp. are of the sliding contact type. Those of 25 hp. and over are of the butt type, the contacts being operated by cams on a shaft that extends through the end of the cabinet to which a handle is connected. Mounted directly above each starter and on the same panel is a "Urelite" enclosed externally operated overload breaker manufactured by the Cutter Electrical & Manufacturing Co.

Types of Lighting Service

To illuminate the walls of the main waiting room above the cornices and up to the skylight, two floodlighting banks have been installed (one bank on each balcony). Each bank contains 35—750-watt projectors to illuminate the opposite half of the room. These floodlighting banks are remote controlled from buttons located in a cabinet near the corner of the ticket office, this same cabinet controlling all the lights in the public spaces in the headhouse.

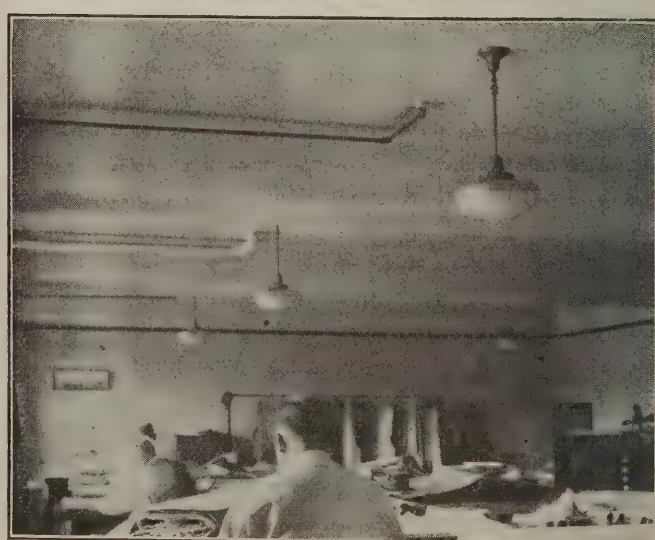
Heavy ornamental bronze torcheres or lighting stand-

Storage Battery Tractor and Trailers for Handling Baggage

ards mounted on marble bases are located along the wall of the main floor of the waiting room. A total of 16 of these are installed.

In the niche in the west wall above the cornice a bank of 18 lights has been installed in a trough reflector to light this space to the same intensity as the side walls and smooth out the shadows cast by the floodlights.

The ticket lobby passage adjoining the east side of the



Typical Semi-Indirect Office Lighting Unit Used Throughout the Offices

waiting room has an arched ceiling, the highest point of which is 80 ft. above the floor. Along the north and south sides of this is an ornamental cornice the same height as the cornice in the waiting room. Twenty-four 100-watt projectors are installed on each side of the cornice to light the ceiling. There are also four ornamental bronze

brackets installed on each side, about 15 ft. above the floor.

Ornamental bronze ceiling fixtures are used in the lobbies adjoining the main waiting room, in the women's waiting room and in the restaurant. Special fixtures of artistic design are used in the main dining room. In the main concourse a rather simple design of fixture is installed. Twelve opal glass globes are hung from a steel tube ring which in turn is supported by chains. All overhead lighting fixtures which are mounted extremely high and in inaccessible places have a special lowering arrangement to permit cleaning.

Trainshed Lighting

Special 200-watt lighting units were designed for the passenger platforms. The corrosive action of the air and gases to which these will be exposed lead to a very sturdy but simple construction with a very few small parts. The general construction is that of a street light or outdoor fixture, having a metal top with enclosing globe. The hood and glass holder are partly made of cast aluminum and partly of Major metal, a special non-corrosive aluminum alloy.

For the baggage platforms an enameled steel reflector is used. It has the standard R.L.M. shape and is provided with a clear Pyrex glass cover to make it air and dust tight. These were furnished by the Wheeler Reflector Co.

There are a total of 1,000 lighting units in the trainshed, all of the 200-watt size. The spacing is about 21 ft. and the height about 21 ft. The trainshed lights are fed from transformers located in vaults under the baggage platforms.

The control buttons are located at the train gates for both baggage and passenger platforms. The baggage platform lights can also be controlled from the baggage room at the foot of the ramps. Each platform is controlled separately by four switches. Two switches control alternate lights over one-half the length of the platform and similarly two switches control the other half.

Office Lighting

The ceiling fixtures in the offices are uniform throughout the building. They are a semi-indirect lighting unit of special design and furnished by the Central Electric Co. The bowls are its standard "Attalite" shape but blown in clear glass instead of opal. The lower part is heavily enameled to reduce the brightness and also to reflect the light to the ceiling. Three hundred-watt lamps are used in a large part of these fixtures. There are a few 200-watt and 500-watt lamps used. A very comfortable and well diffused lighting is obtained from these fixtures with an illumination intensity of from 7 to 8 ft. candles. Even distribution was difficult to obtain an account of the low mounting heights of some floors, the wide spacing and the large lamps required, the spacing being 14 ft. to 15 ft. and the height 8 ft. Two lights are installed in each bay which are from 14 ft. to 14 ft. 6 in. in width and 28 ft. to 30 ft. in length.

Each bay is wired separately and has one circuit each. Circuits are run from cut-out cabinet to base outlet on column on the permanent wall, then to switch outlet in general directly above the base outlet, thence to outlet box at ceiling line. Conduit is used for this portion of the run. From the outlet box at the ceiling an oval duct is run on face of tile to the ceiling outlets. This arrangement provides a very flexible means for rearrangement of lights and subdividing of space.

Special Street Lighting Installation

Heavy bronze lighting standards at the Adams street and Jackson boulevard entrances add to the rugged and massive architectural treatment of the headhouse. The street lighting standards support two G. E. "Novalux" standard basket type street lighting units each with 600 candle power lamps. The two lamps are in series in the secondary circuit of a series street lighting transformer mounted in the base of the standard. The filaments in these lamps are 15.5-volt, 20-amp. type, which are more rugged than the 6.6-amp. street lighting lamps. A total of 40 ornamental street lighting standards are arranged on two circuits with primaries of the transformers regulated for a constant current of 6.6 amp. Along the river drive six stone standards in pyramid form are equipped with four 100-candle power 6.6-amp. lamps. The same transformer arrangement is used on these standards as on the street lighting standards.

Emergency Lighting System

An emergency lighting system, independent of the regular lighting feeders, has been installed throughout the station. To this system are connected the exit lights, fire escape lights, stair lights and scattered lights throughout the public spaces. This system will normally be fed from the lighting section of the main switchboard in the sub-station. In case of failure of this regular service it will be automatically thrown over to an emergency feeder from the Commonwealth Edison Company direct current system. It is switched back automatically to the regular service when that is restored. This will provide sufficient lighting in all public spaces to prevent accident if the regular lighting should fail.

Armature Coil and Field Coil Tests*

In this article we will discuss the troubles encountered in field and armature coils, their detection and remedies. This will include short circuits, open circutis and grounds, and the manifestations of these faults at the brushes.

Field Coil Troubles

Since the shunt fields are nearly always connected in series a portion of the winding of one shunt coil may become short circuited without showing any evidence of heating. This will be attended by pronounced sparking at the adjacent brush studs. Such a defect can thence be verified by taking the voltage drop across the individual field coils. If there is a variation of 10% or less in the voltage drop the winding may be considered normal. If between 10 and 15% it is advisable to consult the machine manufacturer to get the proper readings for the coil and if over 15% variation the winding may be considered defective and should be repaired.

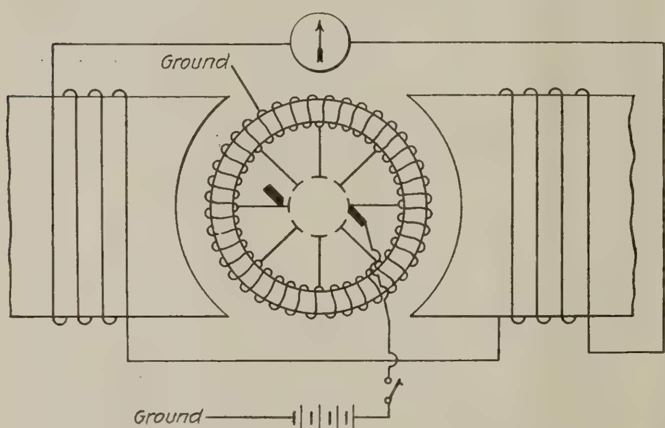
In a compound machine the above trouble may occur in the shunt winding and may be detected and repaired in the same manner, or one or more coils may be connected so that the current flows in the wrong direction through the coil, causing the two field coils to oppose each other. Then as the load increases the effect of the series field

*From a Bulletin Published by the National Carbon Co.

becomes more noticeable. With light load a machine will operate normally but as the load increases the sparking becomes severe at the brush studs adjacent to the defective poles. If the entire series winding should be opposed to the shunt winding an increase of load will be accompanied by an increase in the speed of a motor, or decrease in the voltage of a generator and probably by blackening of the commutator and sparking at all brush studs. This fault may be determined by exciting first the shunt and then the series winding separately and testing the polarity of the poles with a compass, being sure in passing current through the series winding that the direction of the current is the same as when the machine is in operation. One end of the compass needle should be attracted by one pole and repelled by the next pole and so on around the machine. Both the shunt and series windings should attract the same end of the needle to the same pole. This defect if it exists is remedied by reversing the terminal of the faulty winding.

Commutating Poles

The commutating pole winding is connected in a certain direction compared with the armature winding and this relation should never be altered. One side of the commutating pole winding is connected to one side of



Connections for Locating Grounded Armature Coil

the armature. The direction of rotation of a shunt wound commutating pole motor is usually reversed by simply interchanging the shunt field connections. In a compound commutating pole motor the easiest method of reversing the direction of rotation is to interchange the free end of the commutating pole winding and the terminal side of the armature winding. The connection between one side of the commutating pole winding and one side of the armature should never be changed. If these directions are not followed there is a great likelihood of reversing the relation between the commutating pole winding and the armature. This will cause bad sparking and poor speed characteristics.

On commutating pole machines the current passing through the compensating coils is adjusted by means of a shunt usually made of German silver or cast iron grids connected in parallel with the compensating field. The size of this shunt is determined by the manufacturer of the machine. In case the terminals of this shunt become loosened or the shunt is injured the compensation will not be correct and will manifest itself by sparking at the brushes and in severe cases by blackening of the commutator and a tendency toward hunting in the case of a motor. When a commutating pole machine, either generator or motor, is subjected to sudden changes in load it is often necessary to use an inductive shunt connected in series with the non-inductive shunt referred to above. This tends to balance the two parallel circuits and prevent over-compensation when the load is suddenly reduced and under-compensation on sudden rises of load. The remedy for these troubles is obviously readjustment of the shunts but one should be very careful to see that the brushes are operating on the electrical neutral before making any changes in the shunt adjustments.

Open Circuited Armature Coil

The most destructive sparking encountered is caused by an open circuited armature coil which gives rise to a long, heavy spark or flash as the bar connected to this coil leaves the brush and the arc usually sustains itself for some distance or even continuously. This heavy flash will occur at every stud in succession and will therefore not be confused with field trouble which causes continuous sparking at the stud adjacent to the faulty winding. This same trouble may be caused by high resistance end connection which, when the resistance is very high, is practically the same as an open circuit. This high resistance connection is due to the effect of heat or vibration causing the end of the coil to become loosened from the commutator segment. The loose connection may be located by examination or more surely by means of a voltmeter.

The open coil may be easily located since the mica between the bars connected to this coil will be eaten away by the destructive sparking. The leads connected to this coil should be carefully examined and if loose, the trouble may be easily remedied by resoldering the connection, but if the trouble is in the body of the armature it can be repaired only by putting in a new coil. In many cases, however, it may be temporarily repaired by soldering a small strip of copper on the end of the commutator or riser to connect the two bars indicated.

Nearly all large armatures are equipped with equalizer bars connecting the points of equal potential in multipolar machines. These connections tend to equalize the load in various armature circuits. In case they become loose the load will not distribute properly, causing sparking on the heavily loaded circuits. Poor air gap adjustment, for instance, will cause serious over-heating and possibly a burn out in these equalizer connections.

Grounds and Short Circuits

If one of the conductors of an armature winding touches the core the potential of the core becomes that of the winding at the point of contact and if the frame (yoke, housings and base) of the machine be insulated from the ground, a dangerous difference of potential may be established between the frame and the ground. For safety, it is advisable to ground the frame of the machine, but then the potential of the winding at the point of contact with the core will become the ground potential. If the winding be grounded at two points a short circuit is produced and a large current flows through the short circuit which will usually burn the windings before the machine can be shut down. If the machine is a motor a short circuit will open the circuit breaker but not before some damage has been done and the inertia of the load will operate the machine as a generator in case of a shunt and compound motor increasing the effect. If the machine is a generator and a short circuit takes place the

circuit breaker will not open unless power comes over the line from some other source such as a generator operating in parallel with the machine in question or from motors which are driven as generators by the inertia of their load.

High Tension Insulating Tests

The insulation between the conductors and the core which is grounded may, under certain circumstances, be subjected to a difference of potential equal to the terminal voltage of the machine. Due to operating causes, still greater differences of potential are liable to occur. To make sure that there is enough insulation between the conductors and the core and that this insulation has not been damaged, it may be subjected to a puncture test; that is, a high voltage is applied between the conductors and the core for one minute. If the insulation does not break down during this test it is assumed to be ample. The value of the puncture voltage is obtained from the following table which is taken from the standardization rules of the A. I. E. E.:

Rated terminal voltage of circuit	Rated output	Testing voltage
Not exceeding 400 volts	Under 10 kw.	1,000 volts
Not exceeding 400 volts	10 kw. and over	1,000 volts
400 and over, but less than 800 volts	Under 10 kw.	1,500 volts
400 and over, but less than 800 volts	10 kw. and over	2,000 volts
800 and over, but less than 1,200 volts	Any	3,500 volts
1,200 and over, but less than 2,500 volts	Any	5,000 volts
2,500 and over	Any	Double normal rated voltage

For machines that have been in operation for some time use the following table which has been suggested by a large manufacturer:

Rated terminal voltage of circuit	Rated output	Testing voltage
Not exceeding 400 volts	Under 10 kw.	1,000 volts
Not exceeding 400 volts	10 kw. and over	1,000 volts
400 and over, but less than 800 volts	Under 10 kw.	1,500 volts
400 and over, but less than 800 volts	10 kw. and over	1,500 volts
800 and over, but less than 1,200 volts	Any	2,000 volts
1,200 and over, but less than 2,500 volts	Any	3,000 volts
2,500 and over	Any	25% more than rated voltage

A ground often makes itself apparent by signs of burning on the edges of the commutator segment to which the grounded coil is connected and its position may be found by inspecting the commutator. It may be possible to locate the ground by applying current to the armature and if the fault is a bad one an arc may be seen or heard. If neither of these methods are applicable the following one will be found to give good results.

Locating the Grounded Armature Coil

A ground in an armature coil of a direct current machine may be located very simply by the following method: The connection should be made as shown in the illustration with the field circuit entirely disconnected from the armature and its terminals connected across a fairly sensitive galvanometer.

All of the brushes except one side should be removed from the commutator. This set should be connected to one side of a battery, the other side of which is grounded. These brushes should then be shifted until the coils to which they are connected lie directly under the center of the pole pieces. When the switch "S" is closed, current will flow from the brush to the ground through the armature winding. This will induce a momentary impulse of current in the field winding which will cause a kick on the galvanometer. The armature should be rotated step by step and the operation repeated as each commutator segment goes under the brush. As the ground approaches the brushes the amount of armature winding through which the current flows will decrease, decreasing the magnitude of the kick on the galvanometer until when the grounded coil is connected to the brush no kick will be produced. It is important that the brushes should be shifted to such a position that the coil connected to the commutator bar is under the center of the pole pieces, since this increases the kick on the galvanometer.

Zurich Station, Switzerland

Fishing Wires Through Conduit

An easy method of pulling wires through conduits when there are no wires already in place, is to use a piece of sash chain. Determine the number of wires to be drawn into each conduit and then after they are cut to length, remove the insulation for a distance of about 1½ in. from one end. Then with a steel tape or wire, pull the sash chain into the conduit, being careful to connect the chain to the tape or wire so that the narrow end of each link will follow the link ahead and with the wide end or shoulder to the rear. Now connect one wire onto the end link of the chain then skip a link and connect another wire until all wires are connected. This will run the wires to a very nice taper or point so that they will all follow up easily around corners with the least amount of strain and thus avoid any danger or possible damage to the insulation on them. A chain, however, must not be used if there are any wires already in the conduit, as the links may damage the insulation. If it is desired to pull additional wires through a conduit, an easy method is to use a piece of belt lacing instead of the chain; the belt lacing will, of course, have to be punched at one end with holes about every 1½ in. apart, the wires being connected one to each hole.

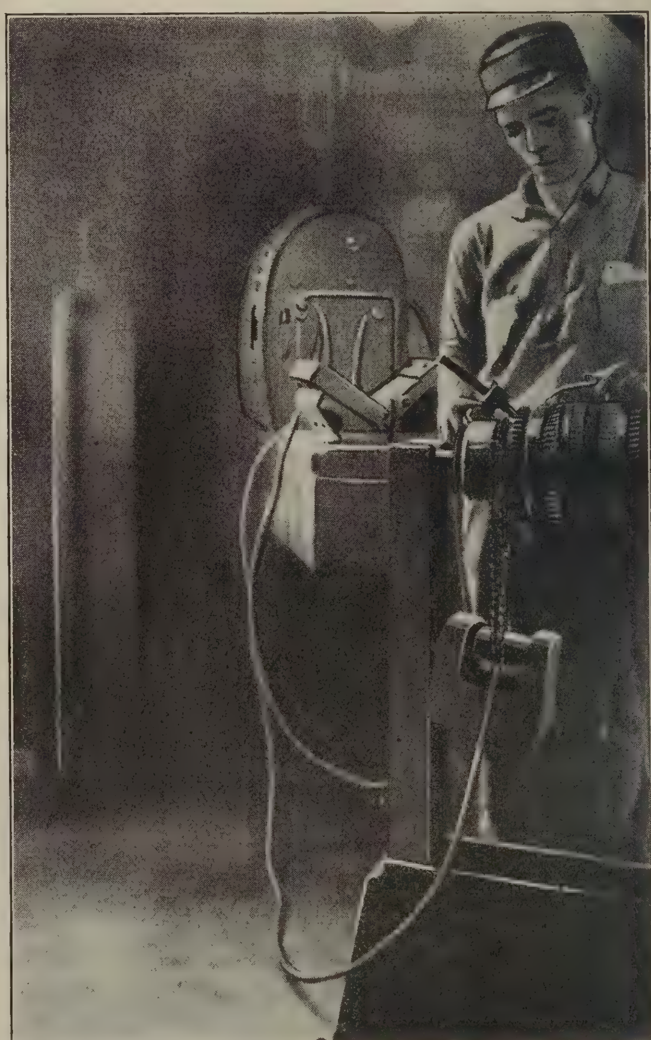
Soldering Transformer

An unusually useful time and labor saving device for soldering is used in the shops of the Southern Pacific at Houston, Texas. It was designed originally for heating soldering irons and has since been adapted to more direct methods of soldering.

The principal part of this device is a transformer which has 68 turns of No. 10 wire on the primary and four turns of 500,000 c.m. cable on the secondary. The core is built up of laminations cut in the shape of a hollow square. They are 12 in. square on the outside, and have a 5 in. square hole in the center and were made from discarded car roofing. The old paint was left on the roofing to provide the necessary insulation between laminations. There are 180 laminations in all, making a pile or core 4½ in. thick.

The primary is supplied with power from the 220-volt, 60 cycle shop circuit and the transformer is controlled by a knife switch in this circuit. The secondary terminals are connected to carbon blocks 6 in. square and 1 in. thick. These blocks are mounted rigidly on the bench in front of the transformer so that their lower edges are about ¼ in. apart and the upper edges several inches apart. The blocks were obtained from the welders who use them for backing up welds.

When a soldering iron is to be heated, the primary switch is closed and the iron is laid or wedged between the carbon blocks. This causes a heavy short circuit current to flow through the iron and the heating effect of the current is localized in the iron by the high contact resistance between the iron and the carbon block.. A 2 or 3-lb.



Soldering Armature Coil Leads to Risers with a Carbon Pencil. The Transformer Is in the Rounded Housing and the Carbon Blocks for Heating Soldering Irons Are Shown in Front of the Transformer

iron can be brought up to soldering heat in about as many minutes.

The transformer is also used for soldering commutator risers to coil terminals. For this purpose a two-turn secondary of No. 4 wire was wound over the other secondary. One end of this secondary was connected to a loop of brass coach window chain and the other end to an electrode having a handle on one end and a piece of locomotive arc headlight carbon about 12 in. long on the other.

The armature to be soldered is placed in a horizontal position. The loop of chain is slipped over the commutator and a 20-lb. scale weight is hung on the lower end of the loop. In this way the chain has good contact with about half the segments on the commutator. The carbon tip of the electrode is then placed against the commutator riser which is to be soldered and the riser comes up to soldering heat very quickly. Wire solder is fed into the joint. The heat provided by this method is constant, the electrode is light and easy to handle and there are no soldering irons to keep in condition.

Ground Currents

By Louis D. Moore

Electrical Engineer, Missouri Pacific

Ground currents, or more particularly, stray ground currents, are an interesting study, and sometimes cause some peculiar experiences. The following two cases are interesting examples of what may sometimes happen when electric current is not confined to "the straight and narrow path."

Fig. 1 illustrates a condition found to exist upon complaint from the local people that persons were being shocked when walking across the ground between two

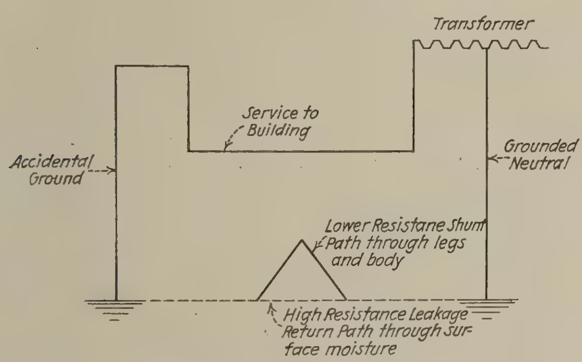


Fig. 1—Diagram Showing How An Accidental Ground on Wiring System Produced Unpleasant Shocks to Persons Walking Between Buildings

buildings. These two buildings, a passenger station and a freight house, were both served from a transformer located between them but considerably nearer the passenger station than the freight house. The neutral of the transformer was grounded. An accidental ground occured on the building conduit system. Apparently neither the regular conduit ground nor the transformer ground were effective in dry weather, possibly due to the nature of the soil, as the condition noted occurred only during wet weather. However, when the soil was wet the surface moisture apparently acted as a high resistance return path from the accidental ground on the building wiring to the grounded neutral of the transformer. When anyone would walk across the intervening space at that time, however, the resistance of the persons legs and body formed a shunt path of sufficiently low resistance to cause a current of very uncomfortable strength to flow through the body. As soon as the building ground was cleared the trouble disappeared.

Fig. 2 illustrates a condition found to exist upon report that when a locomotive was taking water from a steel tank the fireman received a severe shock. A small interurban line crosses the steam line quite close to this tank.

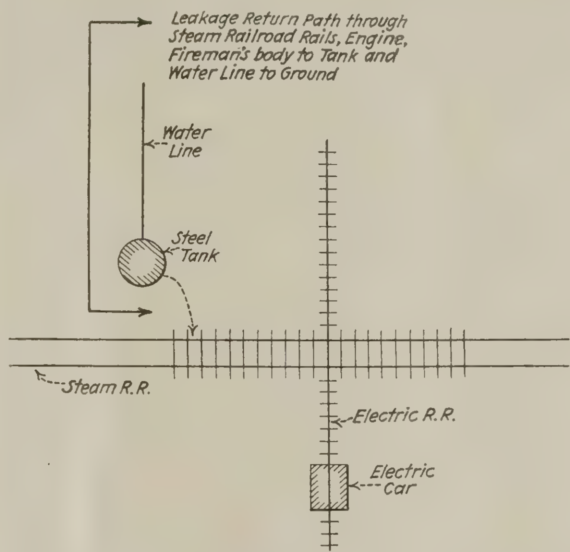


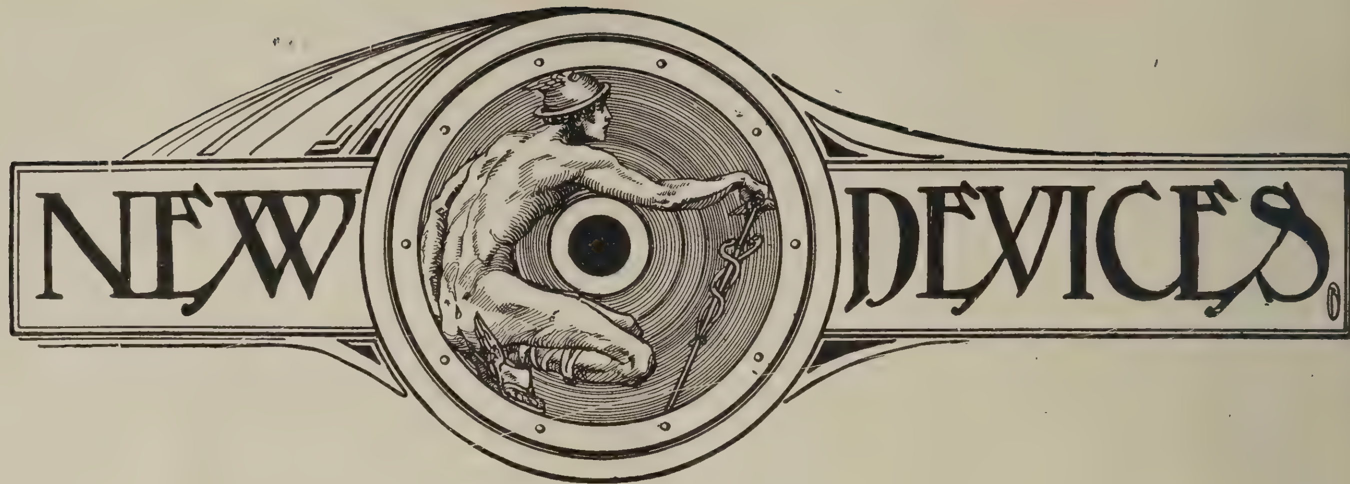
Fig. 2—Sketch Showing How Fireman Received Shock from Water Tank

The bonding on the interurban track is exceedingly poor, in addition to light rail being used. Consequently, the return current from this line, instead of following its own rails, was shunted through the much heavier and better joint steam track, the locomotive tank, the fireman's body, the spout of the tank, and thence through the tank and water system. A voltmeter showed about ninety volts between the steam line and the tank. The trouble was remedied by bonding the track to the tank.

Possibly others have had experiences of interest along this line, and accounts from them would furnish instructive reading.

Be a Pal

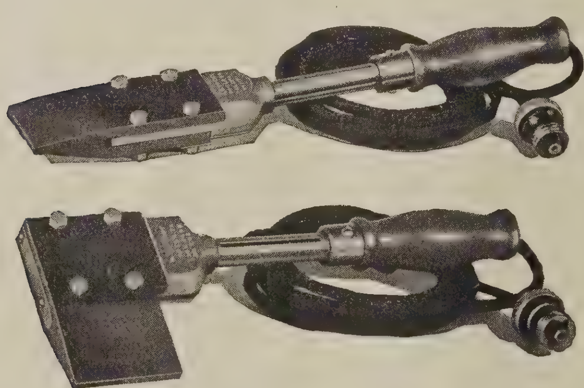
Be a pal to the boys, you know
How rugged the road where they must go;
You know the place where you slipped and fell
Of which at present you rarely tell.
O, the boy may slip, as once did you,
His fall may be worse than the fall you knew!
He needs your hand and your hard earned lore,
For the pitfalls lure till the journey's o'er.
So be a pal to the boys. Just once,
Taught the lure of the depths to shun,
Is more than a million in yellow gold
Which death-stilled fingers no more may hold,
The boy, unlored your aid doth need
Give him a hand, his steps to lead,
And perchance you will find when his story's done,
That you have a share in the prize he won.



Heavy Duty Electric Soldering Irons

Electric soldering irons for heavy duty soldering have been placed on the market by Harold E. Trent, 259 North Lawrence St., Philadelphia, Pa. The irons are made in two styles: a spear shape and hatchet type as shown in the illustrations. Both types have a copper tip in which the heating element is clamped and the manufacturer states that the irons can be connected indefinitely at their rated voltage without overheating the tip or burning out the heating element.

The irons are designed for use on 110-volt circuits and



Spear and Hatchet Type Heavy Duty Soldering Irons

have a power consumption of 500 watts. They have such proportions as to make for easy handling. Ten feet of high grade flexible cord with a two part splug are provided to facilitate connections.

The iron complete weighs 5¼ lb. and the tip is 3 in. wide and tapers to a thickness of ¼ in. at the end.

Bracket Fixture for Line Drops

The Ohio Brass Company is now producing a special fixture consisting of a combination of two porcelain strain insulators mounted on a malleable iron bracket to form a line break fitting, requiring the use of only a single instead of a double cross arm. The purpose of the device is to simplify construction at the pole where lines are dropped down for switches, cutouts, series lighting fixtures, etc.

As illustrated, this bracket is made in two forms. In one, the insulators are in tension; in the other, they are under compression. With the tension unit, if the insulators are accidently broken the line is dropped and it falls clear of the pole, eliminating any danger of grounding there. Trouble is thus readily apparent. This method of support frequently is desirable. The pins which hold

Tension and Compression Types of Line Break Fittings

the insulators to the bracket casting are fitted with lead sleeves which very materially increase the ultimate strength of the unit. The breaking point is said to be ten times that of hard drawn No. 10 copper wire.

For power circuits, or signal circuits where it is not desirable to drop the line, the bracket is slightly modified and the assembly is such that when the line wires are served they overlap or are interlocked with the pins, which hold them should the porcelain break. The brackets are high enough to hold the wires at the same height as the other wires carried through on regular insulators.

Because these units provide for bringing the circuits up to the pole, dropping them for cutouts or lights, and then carrying them up and on to the next pole with the use of only one cross arm, they are said to save nearly half the material and construction cost of the double cross arming necessary with pin type insulators.

Two-Position Headlight Switch

The Central Electric Company, Chicago, has developed a new locomotive switch to meet the requirements of switch engines. With this switch it is possible to control the front and rear headlights independently. It is so designed that it can be mounted directly in front of the engineer, in which case the headlight control is in such a position that it can be operated with the least amount of trouble.

The construction of this switch is such that the mechan-

ism and current carrying parts are entirely inclosed in a cast iron case with overhanging and flanged cover. The operating handle is securely riveted to a stud which operates the switch mechanism and is held firmly in any one of the three positions; that is, full, off, or dim, by means of a steel ball and spring, which at the same time enables it to be moved easily into or out of these various positions.

The current carrying parts are mounted on a heavy heat

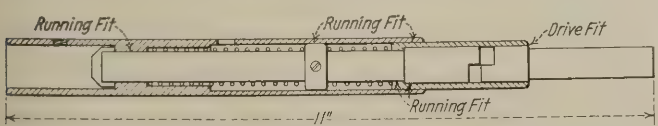
Switch for Controlling Front and Rear Switch Engine Headlights Independently

resisting insulated base. The movable contacts are made from spring temper phosphor bronze while the stationary contacts are rolled stock and no cast material is used for the current carrying parts. The rating of these parts is liberal and they should give long and satisfactory service. The switch is furnished either with or without resistance units as desired. A desirable feature of this switch is its compactness. The overall dimensions are: width 6½ in., height 7 in., and depth 3¼ in.

Power Driven Automatic Screw Driver

The illustration shows a power-driven screw driver, so designed by Stansell Automatic Screw Driver Company, Seattle, Wash., that it can be used in all kinds of wood-drilling machines, electric or air-motors and also on drill presses. It can be used in all classes of woodwork from the plain rough to the finest finish without damage to the surface of the wood.

The motor will run continually as the driver picks up the screws and releases them automatically at any set



A Screw Driver Which Automatically Stops When the Screw Has Been Driven to the Proper Depth

depth. The motor switch is turned on, the driver placed over the screw and pushed down.

The bit has a round shank where an adjustable drill-chuck is used on the motor, or is furnished with a number of one taper shank when specified. The bit is made of special steel and fits into a dovetailed slot. It also holds the driver together. Tests made show that the bit will stand driving 2½-in. screws into hardwood blocks without lead holes.

By the tension of the springs, the bit is forced to the bottom of the screw slot; at that time the clutch ends come together and hold until the screw is driven home. The device has a depth collar that can be easily adjusted to drive screws to a depth of ¾-in.; the collar also holds the springs in position.

The barrel answers two purposes. It covers all working parts, leaving nothing exposed to catch the clothing or injure the operator and does not revolve while the screw is being driven; the end of the barrel is a guide for the screw-head. It is provided with a liner for small screws.

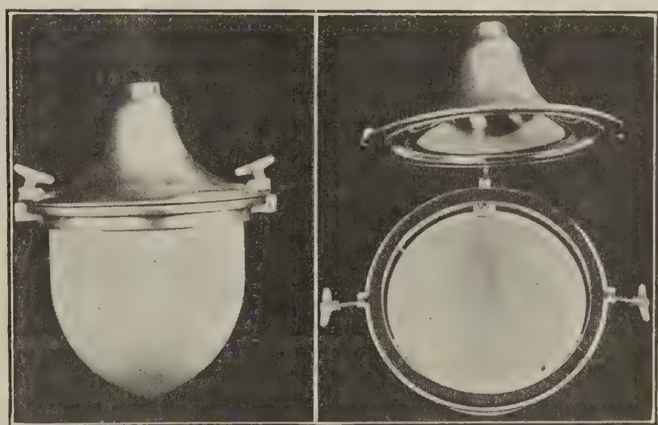
The drivers are made in four sizes, No. 1, 11 in. long, takes screws from No. 20 down to No. 12; No. 2, 11 in. long, takes screws No. 12 and smaller; No. 3, 6 in. long, takes screws from No. 20 down to No. 12; No. 4, 6 in. long, takes screws No. 12 and smaller.

Where the operator stands over his work, a driver 11 in. long is furnished. For overhead work the 11-in. driver is furnished with an extension.

Lighting Units for Train Sheds

A new type of lighting unit used extensively for the illumination of train sheds at the Chicago Union Station, possesses a number of unusual characteristics. The unit was developed by A. V. Boetter Manufacturing Company of Chicago. Its general appearance may be seen in the photograph which shows the lighting fixture in the closed and open position.

The diffusing bowl is made of ripple glass or monax glass and the unit is equipped with a 200 watt lamp with a standard socket or a 300 watt lamp with a mogul socket as desired. The main body of the lamp, that is the hood



Train Shed Lighting Unit Used in Chicago Union Station

and ring, is made either of major metal or aluminum depending upon the conditions under which the lamp is used. The studs and hinge hooks are made of monel metal or bronze. The gasket felt and bezel are flanged for the gasket and a felt gasket is used between the diffusing bowl and the bezel.

The major metal used in the construction of these units is a newly invented metal which possesses a number of advantages over other metals frequently used for such purposes. Major metal may be manufactured with varying degrees of hardness; it has high tension strength, malleability and ductility. Moreover, it is rust proof and does not corrode nor tarnish.

General News Section

The Strom Division of the Marlin-Rockwell Corporation has moved its Philadelphia office to 1211 Franklin Trust Building, 15th and Chestnut Sts. A. W. Wiese will continue as manager in that territory.

The New York, New Haven & Hartford has ordered 5 electric passenger locomotives and 3 electric switching locomotives from the Westinghouse Electric & Manufacturing Company and the Baldwin Locomotive Works.

The Interstate Commerce Commission has postponed the effective date of its second train control order (January 14, 1924), in the cases of the St. Louis-San Francisco and the Central of New Jersey, to July 18.

The General Electric Company has announced its definite decision to purchase a site for a manufacturing establishment in the city of St. Louis. The tract selected comprises about 155 acres of which all but 11 acres is within the city limits.

The Brotherhood of Locomotive Engineers, which attracted wide attention in 1923 by buying a substantial interest in the Empire Trust Company, New York, is now reported to have disposed of its holdings in that institution. The reason given was a desire to concentrate its activities in its own financial enterprises.

The control of J. H. Bunnell & Company, 32 Park Place, New York City, has been purchased by J. J. Raftery and J. G. Dougherty. The Bunnell Company was founded in 1879 and has established a reputation in the manufacture of high grade telegraph apparatus. Plans for enlarging the manufacturing end of the business as well as for the further development of the jobbing end are being worked out.

Orders received by the General Electric Company for the year ending December 31, 1925, amounted to $302,513,380, according to an announcement by Gerard Swope, president of the company. Compared with $283,-107,697 for the year 1924, this was an increase of seven per cent. For the three months ending December 31, 1925, orders totalled $78,636,669, compared with $80,009,978 for the same quarter of 1924, a decrease of two per cent.

Twenty-two baggage cars filled with silk, which arrived in New York City from Japan on January 13, were said to contain 10,000 bales valued at ten million dollars. This silk—two train-loads—was carried from Seattle, Wash., to New York City in 86 hours, and all the way from Yokahama to New York in 15 days. The movement was over the Chicago, Milwaukee & St. Paul and the New York Central.

Progress in Electrification of Austrian Railways

Electrification of the Austrian Federal Railways is progressing in proportion to the release of funds from the balance of the League of Nations credits set aside for investment purposes according to Commerce Reports. In addition to the 56 electric locomotives ordered last year, the greater number of which are already in operation, 50 additional locomotives have been ordered, delivery to be made progressively until the end of 1927. The new type of locomotive is stronger than the former, which was adapted for an axle load of 14.5 tons; the new type is adapted to a weight of 16 tons. Heavier types, with an axle load of 18 tons, may not be introduced at present, as the roadbed of the Austrian railways is unable to support such heavy weights.

It is planned to reinforce the principal portions of the main lines at a future date, more especially the line Vienna-Salzburg, in order to permit the use of a heavier type of locomotive. Orders for the work have been distributed among the four leading electrical manufacturers.

Atlantic City Exhibits

The Railway Supply Manufacturers' Association, through the office of Secretary-Treasurer J. D. Conway at Pittsburgh, has sent out its official circular No. 1, dated January 9, 1926. This includes a diagram of the exhibit space, with information as to the requirements for membership in the association and how to make application for exhibit space.

In addition to the exhibits on the Million Dollar Pier, there will be the usual track exhibits. Arrangements have also been made for the erection of a special new building directly opposite the Million Dollar Pier for machine tool exhibits. The building will be 400 ft. long by 50 ft. wide, with a center aisle. What was formerly Machinery Hall on the Million Dollar Pier will hereafter be known as Assembly Hall and will be utilized for miscellaneous exhibits. Information may be secured by addressing J. D. Conway, secretary-treasurer, 1841 Oliver Building, Pittsburgh, Pa.

Moffat Tunnel Leased

A contract for the rental of the Moffat railroad tunnel has been entered into by the Denver & Salt Lake which provides for a lease for the next 50 years at an annual rental sufficient to retire and pay interest on two-thirds of the tunnel bonds. The contract, based on the present outstanding tunnel bonds, aggregating $9,220,000, obligates the railroad to a supplementary payment of $1,000,-000 if additional expenditures are necessary to complete the project. The original contract will run for fifty years and will cover the 46-year period during which the bonds will be retired, with a provision that the railroad may have an option for an additional 49 years at the close of the first 50 years.

Under the contract, the railroad will be liable for payments amounting to $345,900 a year for the first 16 years; payments ranging from $536,740 to $329,660 during the

following 20 years, and payments ranging from $266,-166 to $187,416 for the next ten years.

The contract will be effective and payments due as soon as the tunnel is completed which will probably be on January 1, 1927, and not later than January 1, 1928, under the terms of the contract. In addition to the annual payments for interest and retirement of two-thirds of the tunnel bonded debt, including two-thirds of the annual maintenance charge of $18,000, the railroad will be required under the contract to keep the tunnel in repair and to insure all inflammable parts of the structure at full value for protection of the district. Under the terms of the contract the rentals on the tunnel are made a part of the operating charge of the railroad.

The Denver & Salt Lake Railway will be incorporated to take over the Denver & Salt Lake Railroad which is now in receivership. W. R. Freeman, receiver, will continue as president. Articles of incorporation have already been filed.

Mexican Train Bandits Kill Fifty Passengers

Approximately 50 passengers on a Guadalajara-Mexico City train were killed on January 9 by bandits who held up the train in the State of Michoacan. The bandits boarded the train at a way station, locked the doors of the cars and systematically knifed or shot the train crew and passengers, robbing them as they proceeded. Several cars of the train were set fire to and burned so that the exact number of victims cannot be definitely known. After having robbed the passengers the bandits uncoupled the locomotive and express cars and ran them down the track several miles where these cars were looted. Troops were dispatched to pursue the bandits as soon as their depredations were made known and a number were apprehended and summarily executed.

Electrification Progress in South Africa

There has been considerable delay in completing the electrification of the Pietermaritzburg-Glencoe Junction section of the Natal main line of the South African Railways, and the cost has exceeded the estimate by about £1,000,000, according to the Times (London) Trade Supplement. The electrification of this section is, however, now almost finished, and the whole length of 174 miles is expected to be under electrical operation next March.

Experience on the open section of the electrified line has shown that there has been a great increase in train loads and a large reduction in running time compared with steam operation. Formerly a steam train with a load of 780 tons downwards occupied 14 to 15 hours on the round trip between Glencoe and Ladysmith. Since electric operation was adopted two round trips are made in ten hours, the down loads hauled amounting to 3,280 tons. Electric locomotives haul freight trains from Estcourt to the Stockton tunnel at a speed of 23 miles an hour, whereas the speed maintained by steam engines did not exceed eight or nine miles an hour. The time occupied by a steam-hauled train of 780 tons in ascending the 1.25 per cent grade from Waschbank to Wessels Nek was 35 minutes. Electrical operation enables trains of 1,640 tons to be hauled over this section in 13 minutes. An aggregate traffic of 27,000 tons a day has been moved over the single Natal track by electric locomotives.

Electrification of 65 miles of track in the Cape peninsula has been begun, and electric trains should be running over the Cape suburban system in 18 months or two years. When the Cape scheme has been completed the South African Railways will have 240 track miles of electrified lines.

New Haven to Operate Hartford-New Haven Buses

The New England Transportation Company, the bus subsidiary of the New York, New Haven & Hartford, has been granted a permit by the Connecticut Public Utilities Commission to operate buses between New Haven, Conn., and Hartford (approximately 37 miles).

This route parallels one of the company's main railway routes and it is understood that the bus service will make possible the elimination of a number of train stops. The area served is densely populated. An independent bus operator sought a permit for the same route but the application was denied.

Other permits in Connecticut granted at the same time are Hartford to Broad Brook (express only)—15 miles—and Hartford to Suffield—17 miles. These lines will supplant or augment motor rail car service. Operations were begun on all the routes recently authorized, except that between Hartford and Waterbury, on January 17. Operations on this last named route has been postponed pending an appeal to the courts by an interurban electric line serving the territory.

The Effect of the Diesel Electric Locomotive on Heavy Electrification

The Metropolitan sections of the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers will hold a joint meeting in the Engineering Societies' building, 33 West Thirty-ninth street, New York, at 8 p. m. on February 18, to consider "The Effect of the Diesel-Electric Locomotive on Heavy Electrification." The principal speaker will be C. H. Stein, assistant to the senior vice-president of the Central of New Jersey; Hart Cooke of the McIntosh & Seymour Corporation, and N. W. Storer of the Westinghouse Electric Company.

Four Appointments in International General Electric Company

A. S. Durant, formerly manager of the department of the Americas, has been made a vice-president of the International General Electric Company, in charge of commercial relations and with headquarters in New York City. James C. Ryan, formerly sales manager of the department of the Far East, has been appointed general sales manager with responsibility for all sales of apparatus and supplies. E. A. Baldwin, formerly manager of the department of Europe, has been appointed manager of the Schenectady office, with general supervision of the Schenectady office and responsibility for engineering and contract relations. W. J. Edmonds, comptroller of the company with headquarters in New York, in addition

to his former duties now has executive direction of the activities, with the exception of sales effort, of the International foreign sales companies.

Okonite Opens Branch at Seattle

Another office has been opened on the Pacific Coast by The Okonite Company also The Okonite-Callender Cable Co., Inc., in the Hoge Building, Corner Second Avenue and Cherry Street, Seattle, Wash. This new office, in connection with the branches already established at San Francisco and Los Angeles, places Okonite products and service within the immediate reach of buyers all along the Coast.

Personals

G. E. Brown, general foreman electrician, Northern Pacific Railway Company, resigned on January 15 to accept a position with the Westinghouse Electric & Manufacturing Company, as salesman, transportation department with headquarters at 2303 North East Kennedy Street, Minneapolis, Minnesota. Mr. Brown succeeded R. F. Castner, who has been appointed manager of the Westinghouse branch at DesMoines, Iowa.

Herbert S. Balliet, assistant terminal manager of the Grand Central Terminal, New York City, and signal engineer of the Electric division of the New York Central, has been promoted to engineer of train control for all New York Central lines, reporting to assistant vice-president C. C. Paulding, of the law department. Mr. Balliet has been for several years secretary of the New York Central Lines Automatic Train Control Committee, a body consisting of the six signal engineers of the principal roads in the New York Central System. He was born at Neffsville, Pa., on February 26, 1868, and entered railway service in 1883, as a telegraph operator. He served as station agent and train dispatcher; as operator and later in special service for the Western Union Telegraph Company and for a time as operator for the United Press Association. In 1893, he entered railroad service on the Lehigh Valley, and successively for 12 years was batteryman, maintainer, foreman, supervisor and assistant signal engineer. Since March, 1905, he has been at the Grand Central Terminal, New York, first as engineer of maintenance of ways and later as assistant terminal manager. He has been signal engineer of the Electric division since May 1, 1907. Mr. Balliet is secretary of the Signal section of the American Railway Association, which office he has held since 1917. He has been active in the work of this section, and its predecessor, the Railway Signal Association, since its earliest years, and was president of the association in 1910. He was a member of the automatic train control committee established by the United States Railroad Administration (1919).

H. S. Balliet

E. W. McCord has been appointed general foreman electrician for the Northern Pacific succeeding G. E. Brown resigned. Mr. McCord entered the services of the Northern Pacific in May, 1925, and since that time has served in various capacities in the mechanical and electrical departments.

William K. Vanderpoel, general superintendent of distribution of the electrical department of the Public Service Electric & Gas Company, New Jersey, has resigned to become vice-president and executive engineer of the Okonite Company and the Okonite-Callender Cable Company, Inc., makers of wire and cable for electric purposes, with factories at Paterson and Passaic, N. J., and general offices in New York City. Mr. Vanderpoel went to the Public Service Company in 1907 as superintendent of distribution for the Newark district, and on January 1, 1916, he was made general superintendent of dirtribution. During the ten years that he was in charge there was a large expansion in business and equipment; more than 500 miles of transmission lines were added and over 13,000 additional miles of wire strung and the work of changing the distribution lines from two to three phase was carried forward until it is now nearing completion. Mr. Vanderpoel has for a long time been identified with the American Institute of Electrical Engineers and the National Electric Light Association. In the latter organization he is at present vice-chairman of the National Technical committee, was chairman of the Overhead Systems committee in 1920 and 1921 and has at various times served as chairman or member of other important committees. His work in connection with wood preservative methods, as embodied in the reports for 1910 and 1911 of the committee on the Preservative Treatment of Poles and Cross Arms, of which he was chairman, constituted a valuable contribution to the industry. Mr. Vanderpoel is a manager of the American Institute of Electrical Engineers, and has served or is serving on a number of the committees of that association. Prior to entering the Public Service organization, he was engaged in mining in South America. He has had telephone engineering experience in this country and Cuba and for a time served as assistant purchasing agent of the Florida East Coast.

W. K. Vanderpoel

Trade Publications

Curtis Steam Turbine Generators is the title of a 44-page, illustrated bulletin issued by the General Electric Company, Schenectady, N. Y., in which are shown a large number of photographs of actual installations.

Railway Electrical Engineer

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Electric Locomotive Classification

A new system for classifying electric locomotives, called the "Standard" system, is proposed in an article elsewhere in this issue. It has the advantage of simplicity and permits certain designations which are not possible with the Whyte system now in general use. For example, an "0-4-0" locomotive under the new system is classified by the single letter "B" and a "2—4+4—2+2—4+4—2" locomotive is designated by the symbol "2 (1—B+B—1)." The new system also provides for special cases when guiding and driving wheels are included in the same wheelbase. Manufacturers of electric locomotives in this country have tentatively accepted the new system and it is used quite commonly in Europe. Unlike the adoption of the metric system of measurement, which would require the changing of many jigs, dies, etc., the proposed locomotive classification system requires only that records, text books and magazines adopt a separate designation for electric locomotives. This depends on the willingness of those who use the records and magazines, to use it, and on the persistence of the manufacturers in exploiting it. There are apparently good reasons for the introduction of the system and if the manufacturers use it consistently in their literature, it is not at all unlikely that the "Standard" system for electric locomotive classification will in time receive general recognition.

Labels for Reflectors

It is common knowledge among those whose duty it is to install lighting systems that the voltage rating of the lamps should correspond with the voltage of the circuit on which they are used. Incandescent lamps are rated for a given light output, when operated at the voltage indicated on the label. If the lamp is burned at a higher voltage, a short life will result; if operated at a lower voltage, it will not give the proper amount of light. Furthermore, if the lamp used in a given reflector is not the right size, it is highly probable that the light distribution from that unit will be poor and the lamp itself may be exposed so as to cause objectionable glare.

The man who plans and installs the lighting system for any building or group of buildings almost never has anything to do with its maintenance. Furthermore, the installer is seldom in a position to inspect the system periodically or to insist on its proper maintenance.

The user of the light wants good light, but does not always know the best way to get it and after shopmen have shifted lights about for sake of convenience (one reflector is robbed so that light may be had at some other location without delay) there is no longer any record of what size or what voltage lamp is required. The simple expedient of labelling the reflector when it is installed will probably be of material assistance in keeping the unit fitted with a lamp of the right size. In cases where there is a variation of voltage in different locations on the same property, it might also be advisable to include the voltage rating on the reflector label.

Wanted—An Inventor

Under certain conditions the flushing of batteries is a job that takes considerable time to accomplish. For example, in large yards where cars that require flushing may be located almost anywhere, it is no small task to carry sufficient water to flush any appreciable number of cells. This is particularly true in yards where there are no runways for operating any device mounted upon wheels.

The matter is still further aggravated by the fact that the opening for flushing some batteries is very small. In some cases as much as five gallons of water are required to flush a single set of batteries and it is obvious that a great deal of time is consumed in doing this work.

There is urgent need for some of our inventive geniuses to get busy and devise some plan and apparatus for flushing batteries quickly under adverse conditions. It is simple enough when every facility is available; it is difficult when the work is surrounded by many obstacles.

Extraction Type Turbines

The question of whether power should be generated or purchased is one which comes up every time it is necessary to build a new power plant or enlarge an old one. The large power generating units in central stations can generate power at a lesser cost than is possible in small plants and if power is purchased the railroad has less plant to maintain and is not burdened with the added capital cost of power generating equipment. At one time air compressors were all steam driven, but now many are electrically driven and this creates an increased demand for electric power.

At all railroad shops, however, there is a demand for steam. It is used for blowing-up engines, for heating and for a variety of other purposes. Power plant boiler pressure is usually in the neighborhood of 200 lb. and

much of the steam used is supplied through a reducing valve. This means that superheat representing a considerable amount of mechanical energy is lost.

Consideration of all demands for steam will frequently show that a steam turbine can be used in the place of a reducing valve and that by this means a large amount of electrical energy can be developed with little loss to the value of the steam as used at the lower pressures. Recent developments in extraction or bleeder type turbines have increased the desirability of using steam in this way. These turbines are now available in a variety of forms with different kinds of regulating apparatus, and the result of this development is that there has recently been a considerable increase in the sale of small turbines in the industrial field. Railroad and industrial requirements differ but they are fundamentally the same.

Extracting steam from several stages of a turbine introduces an involved problem in thermodynamics, but the data is available for the asking and when there is need for building a new power house or for getting more out of one that is overtaxed, the possibilities of the extraction type turbine will probably be worthy of investigation.

Educational Associations

During February an association called the Railway Electricians Educational Association was organized. It is made up of electricians employed by the Pullman Company and all the railroad companies operating in Minneapolis and St. Paul. The object of the Association is educational only; any questions regarding personal grievance or personal working conditions are not to be considered by the Association. Any electrician, electrician apprentice or electrician helper employed by a railroad company or the Pullman Company is eligible for membership. The subjects handled will consist primarily of open discussions on troubles and their remedies and of the report of committees previously assigned to investigate some particular subject. Social functions will be included in the activities of the Association. Regular dues are nominal, being only 15 cents per month for helpers and 25 cents per month for electricians.

Such organizations as this constitute a valuable asset both to the member and to the railroad he is working for. During the past few years the electrical industry has progressed more rapidly than any other. With a few exceptions, however, the use of electrical equipment on the railroads has not kept pace with the development which has been made in the industrial field. Expansion of electrical work on the railroads is practically certain to follow that in other fields. Education in several forms will be one of the most important factors in fostering this development. It assists a man to do his everyday work easily and well, it provides him with an insight into other things going on around him and it places him in a position to show others how things can be done better electrically than any other way.

The function of such organizations as the Railway Electricians Education Association is education and the purpose of this magazine is also education. The *Railway Electrical Engineer* will therefore, be glad to give publicity to the activities of such associations and to assist in every way possible in helping them to meet with the success which they deserve.

Train Control Maintenance Costs

The various types of train control apparatus which have been installed by the railroads are now being weighed in the balance and the factors which govern acceptance or rejection will be principally performance, first cost and maintenance costs.

A statement of the cost of installing train stop or train control appears for the time in the six final inspection reports issued by the Interstate Commerce Commission recently with respect to installations on the Southern Pacific, the Galveston, Harrisburg & San Antonio, the St. Louis-San Francisco, the Norfolk & Western, the Great Northern and the Chicago, Burlington & Quincy. This new practice of the Commission in including an accurate and unbiased detailed statement of these costs in its reports will be of decided value to the various railroads that are interested in knowing what the different types of train stop or train control actually cost under the various methods of construction and application used on different roads. When a number of such reports are available it will be possible to determine on a definite basis the relative merits of the different types of equipment available and also to determine if a certain volume of traffic will justify the more complete systems including speed control.

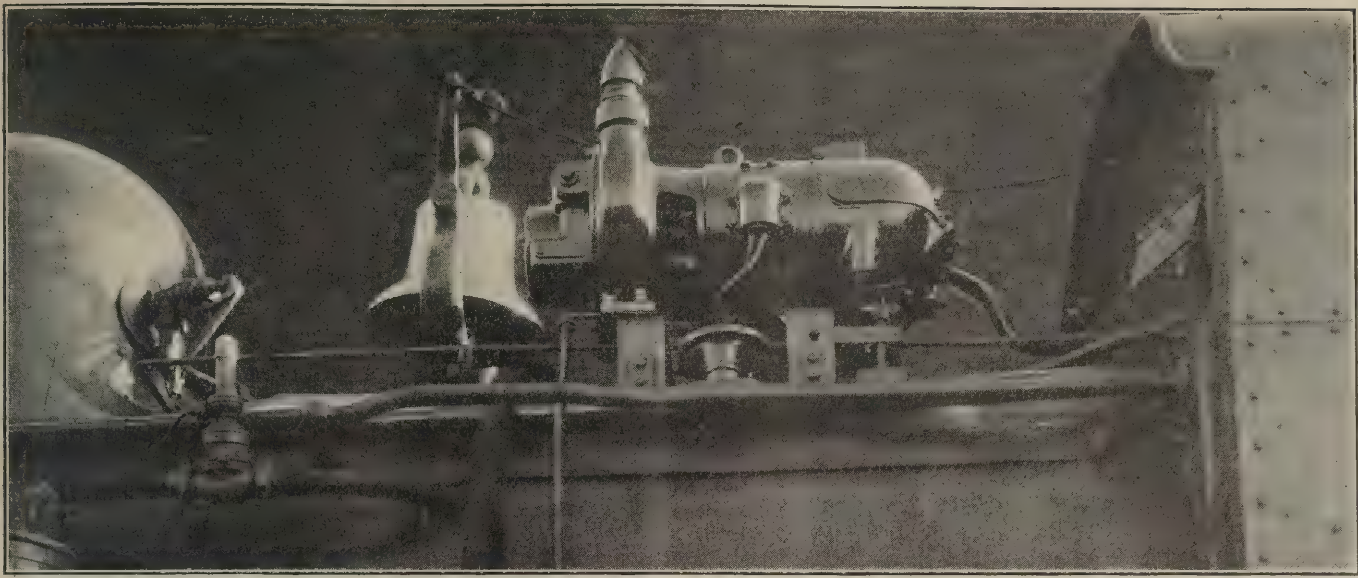
Performance and first cost, however, should not be the only factors governing the choice of an installation. Maintenance and operating charges are equally important and it is to be hoped that such information will soon be available concerning all types of equipment for those whose experience has been limited to one or two types.

The Awakening of the South

The railroads of the south are rapidly developing and increasing their facilities. There are few roads, if any, that have not under contemplation or actually under construction some definite building and construction program.

Double tracking of lines for hundreds of miles is being undertaken in some localities. Automatic signaling installations as well as numerous interlocking plants are being put into service at points where such equipment was decidedly scarce a few years ago. There is hardly an engine terminal of any size or a group of shops where larger repairs are made to locomotives that some increase in facilities is not either planned or in progress. One of the greatest underlying reasons for this development of the south is the continual extension of hydro-power transmission lines, which is gradually spreading a network over a large part of the southern states. Almost unlimited power is available at very attractive rates and with labor plentiful, it is not surprising that many industries are moving down from the north to locate where manufacturing conditions are more favorable.

The railroads are naturally benefited by such migration and are preparing to take care of increased traffic which has already materialized in some sections and is certain to increase in others. New roundhouses, machine shops, yards and repair shops are springing up on every hand to take care of increased business which is bound to come. Electrical repair facilities on many of the railroads are being gradually increased, and one road which operates exclusively in southern territory has recently been authorized to convert every shop on its line to electric operation.



Turbo-Generator Mounted on Locomotive

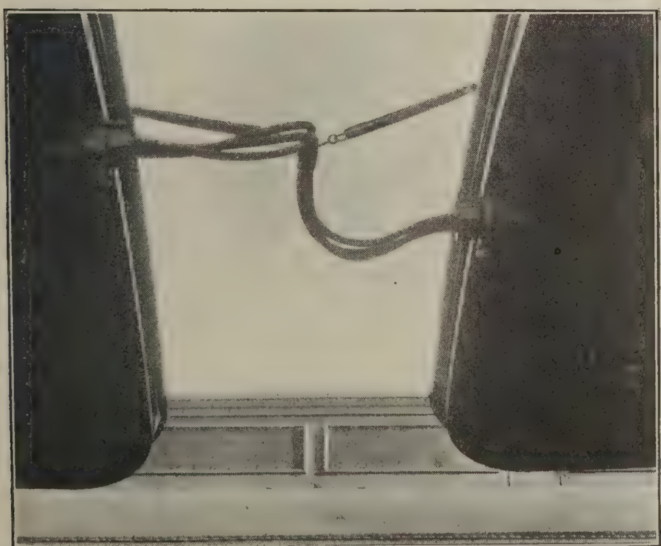
Suburban Coach Lighting on the B. & M.

Turbo-Generator Mounted on Boiler Top Furnishes Lighting Current for Locomotive and Train

By P. J. Callahan
Supervisor of Car and Locomotive Electric Lighting, Boston & Maine R. R.

IN an effort to provide a satisfactory and economical lighting installation for suburban service, the Boston & Maine has placed in service two trains of 11 and 8 cars, equipped for what is now known as locomotive train lighting.

This installation was decided on, after a very thorough investigation of all lighting systems, and to date the results obtained have been very satisfactory.



Showing Method of Suspending Train Line Connector Between Cars

The equipment consists of a Pyle National 7½ kw. turbo-generator, mounted on the locomotive, and this generator supplies current for the locomotive lights, as well as for coaches which may be connected to the locomotive.

Locomotive

The turbo-generator is mounted on the boiler, directly in front of cab, on fireman's side. It is mounted parallel with the boiler, sufficient clearance being allowed, between turbo and cab, to permit of the easy removal of armature.

The conduit and wiring installation has been made as simple as possible, consideration, however, being given to the fact that the installation must be rugged, in order to withstand the excessive vibration with which it must contend.

Since to a great extent, the successful operation of this equipment is dependent upon the train crew, it is essential that every effort be made to make the operation of switches, etc., as simple as possible. In line with this thought, there has been installed a "safety switch" in the locomotive cab, which controls the train circuit. This switch is mounted on the back-board, sufficiently close to engineer's side as to be entirely accessible to him.

The wiring is arranged as follows: from the generator, a pair of flexible 4/0 wires are carried to the safety switch in the cab, through a 2½ in. conduit. From the load side of switch, two pair of 4/0 wires are carried, one pair returning through safety switch box to front end of locomotive, terminating in a train line plug, which in turn is housed in a train line receptacle, mounted on a bracket on the front end, to the left of center line. This receptacle is not connected to the locomotive wiring, but is used as a protective housing for the plug, which would otherwise be exposed to contact with the locomotive.

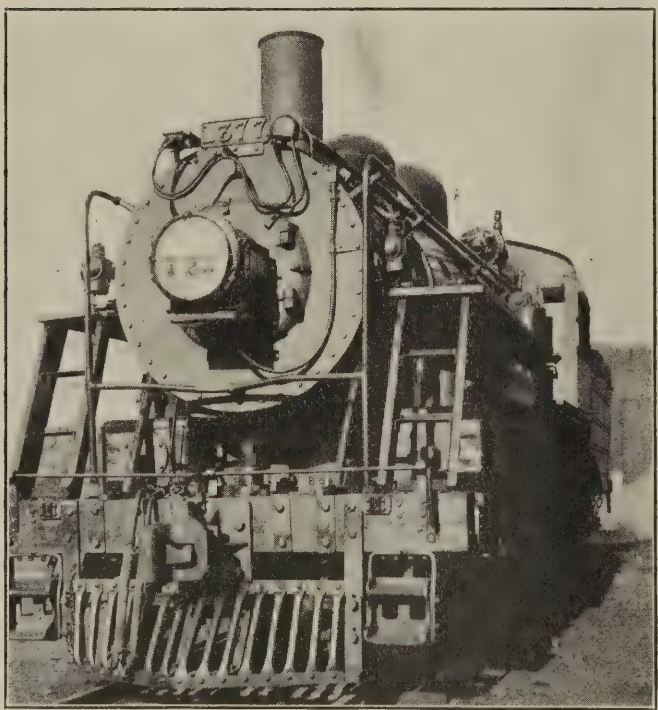
From the generator to the front end, the wires are carried in 2 in. conduit.

From the safety switch box in cab, two 4/0 wires are carried in 2 in. conduit to a train line receptacle beneath the engineer's seat, on the outside. From this receptacle connection is made with tender, by means of a train line plug, which is attached to a pair of 4/0 wires extending to rear of tender, where a construction exists similar to that on the front end. All conduits are rigidly attached to the locomotive.

As far as the locomotive is concerned, the turbo-generator maintenance costs are not greatly increased over the smaller type of turbo-generators intended for locomotive lighting only.

If the conduit and wiring are properly installed, no great trouble should be experienced.

As the number of cars per train was bound to average eight or more, it was considered advisable to use 4/0 wire, in order to hold the voltage drop at a minimum.



Method of Mounting Bracket for Housing Receptacle on Front of Locomotive—Used Only When Connector Is Not in Use

It is essential that special attention be given to the mounting of the turbo-generator. The brackets must be rigidly attached to boiler, and the turbo-generator securely fastened to brackets. It is also important that turbo be mounted absolutely level on brackets. Failure to observe these conditions will result in the loss of ball-bearings, and through this loss serious damage will occur to armature and field windings.

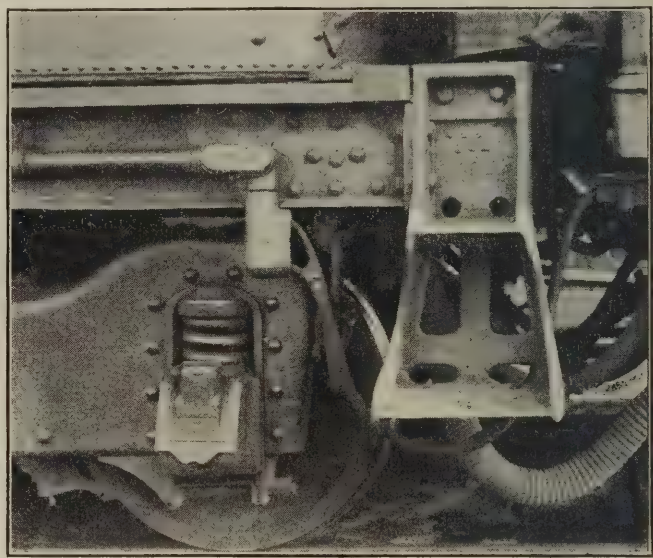
Coaches

The coach installation has been made as simple as possible. On the other hand, every effort has been made to provide adequate light at the lowest possible cost, consistent with good practice.

In line with this plan, 6 center fixtures have been installed, which are distributed equally. These fixtures are Safety Co.'s No. 19287, and are equipped with a No. 18676 shade, and a 50-watt type C lamp. On each platform a Safety Co. No. 19281 vestibule fixture is installed, equipped with a 25-watt lamp.

The conduit and wiring consists of a 2½ in. conduit carrying three 4/0 flexible wires, from a train line receptacle on one end of car, to another receptacle on the other end.

Where the conduit enters roof to the train line receptacle, the conduit is bent to the roof curvature, and extends inside for a distance of approximately one foot. Where the conduit enters roof, copper flashing is used to prevent leaking.



Method of Installing Connection Between Cab and Tender

At the saloon end of the car roof, a T Condulet is inserted in conduit line, from which a ¾ in. conduit extends through roof of car to saloon, carrying a pair of No. 12 flexible wires to cut-out box.

Inside of Coach Showing General Lighting Arrangement

From the cut-out box, these wires are carried in two-

wire "Wire Mold" to the fixtures. Wire-mold has been used on account of the ease of application, low first cost, and its general appearance.

The train line connectors are held in position by a spring about 12 in. in length, one end of which is connected to a ring attached to the center of train line connector, and the other end of which is connected to a hook on car roof.

This arrangement permits of the passengers passing from car to car, without striking their heads against cable, and also allows for the swing of cars when passing over curves.

The cost of maintenance of the coaches is also very small, being confined almost wholly to lamps. With the

Showing Bracket for Mounting Housing Receptacle on Rear of Locomotive

regulation obtained from the turbo-generator, exceptionally long lamp life is obtained.

It has been found necessary to overhaul the train-line receptacles about once a year. As the covers are open practically all the time, a quantity of dirt is blown into receptacles, which, if allowed to remain, will cause serious damage to receptacle, and also result in a failure.

To date the service obtained from this installation has been all that could be desired. Considerable favorable comment has been received from the passengers, which has led to the belief that efforts to provide a satisfactory lighting have been successful.

In connection with this installation, an auxiliary battery was installed, consisting of 54 Edison A-4 cells. Arrangements were made for charging this battery from the turbo-generator. To care for this charging, a 64-volt train lighting automatic switch was installed in the locomotive cab, on the generator side of safety switch.

On account of the battery voltage on charge, it was necessary to divide battery into two equal parts, and charge same in parallel. A four-pole, double-throw switch, together with necessary resistance units, were applied to a small panel which was located in a convenient place in car.

This installation has worked out very satisfactorily, but it is not felt, however, that the battery is absolutely necessary, inasmuch as the possibility of failure of turbo-generator is so remote.

Automatic Chicken Feeding Device Becomes Electric Hammer

The peculiar pranks which fate plays in the development of new apparatus is aptly illustrated by the development of a new electric hammer working on the principle of the electric-magnetic coil and its attraction for an iron core. The hammer is the direct result of an attempt, during spare moments, to invest an automatic electric dispenser of feed for a flock of chickens, when the question of caring for them arose in planning a vacation.

Syntron Electric Hammer

The inventor of the new hammer is Carl Stanley Weyandt, vice-president of the National Electric Manufacturing Company of Pittsburgh, Pa. With a friend, he had conceived the idea of making an automatic feeder regulated by an ordinary kitchen clock which, at regular intervals, would supply the chickens with a definite amount of grain. A part of the apparatus was an ordinary magnetic coil. One evening, when this was attached to the electric circuit and the two men were observing the pull this coil exerted on a nail acting as a core, the nail came flying through and hit the top of the work bench.

The result was that thoughts of vacation and automatic chicken feeders were forgotten, and within a short time the idea of the nail and the electro-magnet had been converted into the Syntron electric hammer. This hammer operates on ordinary 60-cycle electric circuits, and strikes 3600 blows per minute on the shank of any tool inserted into the bit. In contrast to the usual motor-driven hammer, the new device has only one moving part—the piston, which is drawn back and then hurled forward through a bronze barrel by magnetic force.

The syntron hammer is used for drilling holes in concrete, brick or stone, for smoothing stone or concrete surfaces, for bush hammering, cutting, channeling, etc. When used with a star drill, the hammer is rated to drill concrete to a depth of three inches per minute. It is manufactured by the National Electric Manufacturing Company of Pittsburgh, Pa., and is distributed in all countries outside the United States by the Westinghouse Electric International Company.

The Future of the Diesel-Electric Locomotive

A Discussion of the Effect This Type of Motive Power May Have on Heavy Electric Traction

"THE Effect of the Diesel-Electric Locomotive on Heavy Electrification" was the subject for a meeting of the New York sections of the four founder engineering societies held in New York on February 18. The speakers, however, did not adhere rigidly to the subject and the steam locomotive and all kinds of traffic conditions were considered.

A Railroad Man's Attitude

The first speaker was C. A. Stein, assistant to the general manager, Central Railroad of New Jersey. He said that he considered the principal fault of the present steam locomotive was that it was encumbered with too many appliances, too many things to get out of order and put the locomotive in the shop. Train control, he said, aggravates this situation. Mr. Stein stated that he has hoped for years that some form of self-contained unit would be produced which would avoid the high investment cost of electrification. He believes the Diesel-electric locomotive may have a wonderful future and stated that it was his personal belief that the Central Railroad of New Jersey would never be electrified. His principal objection to electrification was that it is difficult to handle traffic with electric locomotives on one line, when there are many points of interchange with other roads.

In concluding his remarks he outlined the following advantages of Diesel locomotive: It is a self-contained unit. No heavy investment is required to meet peak traffic demands. A change from steam to Diesel power can be made gradually. The Diesel engine introduces no danger from third rail or overhead wires. No power house or distribution system is required. The Diesel engine has a greater thermal efficiency than any other prime mover. The mechanics for maintaining a Diesel locomotive do not need to be as highly skilled as those required for an electrification system.

Place for Diesel, Steam and Electric Locomotives

The second speaker was Hart Cooke, McIntosh-Seymour Corporation, Auburn, N. Y. Mr. Cooke outlined a method for determining from traffic conditions what type of motive power is most desirable. In doing this he assumed that Diesel locomotives can be obtained in any capacity and that the relative values of weight, cost and availability, etc., are as shown in Table 1. Curves in Fig. 1 were included in these calculations, but as pointed out later in the discussion the curve for the Diesel-electric locomotive is that for a much heavier unit than either the steam or electric locomotive.

Table 1

Locomotive	*Steam*	*Diesel-electric*	*Electric*
Tractive Effort	See curve	See curve	See curve
Weight per hp.	100	150	75
Cost per hp.	100	300 to 400	300 to 600
Fuel Cost per hp.	100	30	37
Time in useful service	100	200	225

With the above as a premise Mr. Cooke proceeded as follows:

"We will now look into the requirements of some classes of railway service. In cities where the traffic congestion has become very great, it has been found best, where the traffic justifies the expense to put these rapid transit railways underground.

"From the fact that the traffic is heavy enough to justify the expense of putting the rails underground, only very heavy traffic need be considered.

"Also from the nature of the service a great many stops are required. This means, to maintain a schedule that the public would appreciate, the accelerations at starting must be the maximum that can be used without discomfort to the passengers. This requires tremendous power capacity for a train with the minimum weights carried by the train.

"From the fact that these railways are entirely underground and from the nature of the traffic, the trains and stations will be crowded with passengers; therefore, it is very important that no objectionable gases or excess heat be present.

"From the nature of the traffic, the maximum power requirements are only for short periods of acceleration and there will be a relatively large number of trains per mile road and a large power requirement per mile road.

"Let us now see how the various types of power work out for these conditions. To save time we will eliminate the steam locomotives as these would be too objectionable on account of the smoke and gas.

"For Diesel-electric locomotives the tractive effort curve is suitable for the high accelerations required. The weight of the locomotive, however, added to the train would increase the power necessary to give the desired accelerations. While the exhaust from the Diesel-electric locomotive would only be about one-eighth as much as from a steam locomotive, in dense subway traffic this would be objectionable. On account of the maximum power being required for only short intervals, the average power output would be low while the investment in locomotives based on the maximum power would be very high.

"For full electrification the tractive effort curve is the best that could be had for maximum accelerations. The weight, especially if the motors are put on the passenger car trucks, are minimum so as to get maximum acceleration with the minimum of power. There is no gas, and the minimum amount of heat is liberated in the subway. Because of maximum power only being required for acceleration, the effect of the diversification factor makes the capital cost of providing an electric power station a minimum, and the high traffic density per mile of road will reduce the relative cost of transmission lines and third rail. The fuel cost on account of the power being generated in an efficient power house will be low. Taking these things all together, and balancing the operating results against the capital investment necessary, it will be found that the relative results will be about as follows:

"If a Diesel-electric locomotive is used the weight of the train would be increased say 30 per cent, which would require approximately 30 per cent more power to give a certain desired acceleration, and the relative cost of the locomotive would be $1.30 \times 300 = 390$.

"If motors are used on the trucks, the weight of the train will only be increased, say, 10 per cent and the rela-

tive cost of this electric arrangement would be 1.10 × 300 = 330. The diversification factor might reduce the size and cost of the power house say one-third, which would reduce the total capital cost for electrification by, say, one-half of this amount or one-sixth, this would work out five-sixths of 330 = 275, which indicates that the capital cost would be less for electrification with this dense traffic.

"For fuel costs, this would be 1.3 × 30 — 39 for the Diesel and 1.1 × 37 — 40.7 for electrification. The difference of these figures is only 1.7, which would be too small an item to justify the increased capital cost for the Diesel electric shown. Therefore, full electrification gives the very best possible arrangement in every way for this particular service."

Mr. Cooke then proceeded by the same method to consider heavy suburban service, heavy main line traffic, light main line traffic, long branch line service, short branch line service and switching. From the figures obtained in each case he drew the following conclusion:

"To sum up, for very light traffic, the freight and through passenger traffic can best be handled by the steam locomotive, and the local passenger traffic by rail cars to

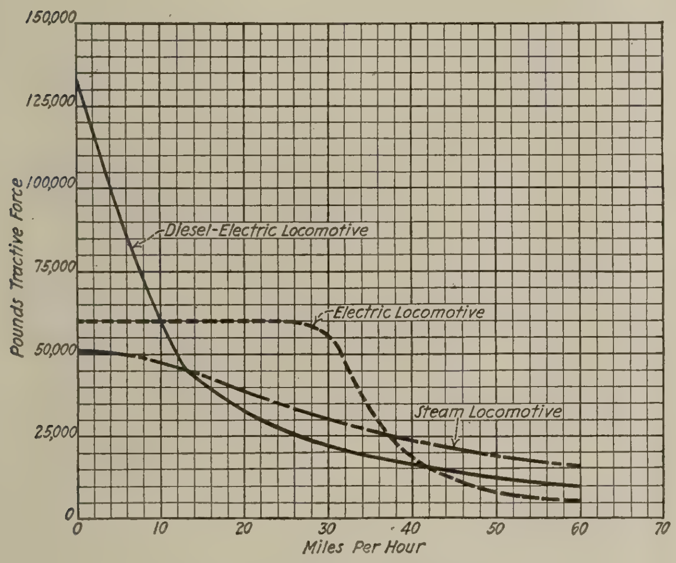


Fig. 1—Tractive Force—Speed Characteristics of Steam, Electric and Diesel-Electric Locomotives

keep the capital expenditure to a minimum, the traffic not being enough so the savings in the operation of Diesel-electric or full electrification would justify the increased capital cost.

"As traffic increases, changed conditions should be carefully analyzed to see where the steam locomotive should be supplemented by Diesel-electric, the Diesel-elctric making the best showing where it can operate the most miles per day. This is along the same lines as grade reduction, curve elimination and permanent bridges for the road itself.

"The capital cost for full electrification is variable and becomes less as the traffic density increases. It is a rugged arrangement and can give lots of service at a low fuel cost and for heavy traffic, as can be seen by the figures given, the capital costs are reduced to an amount which the fuel saving justifies.

"Diesel-electric has this difference from full electrification, that the investment can be made gradually and the benefits obtained at once.

"All of the above shows that the three kinds of motive power are supplementary: For light traffic,—steam. For heavier traffic,—Diesel-electric, and for very dense traffic,—full electrification."

Diesel Locomotive Limitations and Possibilities

Norman W. Storer, general engineer, Westinghouse Electric & Manufacturing Company, the third speaker, presented a paper describing the characteristics of Diesel-electric locomotives, laying particular stress on the electrical equipment and outlining its possibilities and limitations on the basis of these characteristics. An abstract of the paper follows:

The Transmission System

The great problem after the engine itself, is the transmission of the energy developed by the engine to the driving wheels. Various methods have been tried; the direct mechanical connection is more or less satisfactory for very small outputs; the hydraulic with a little larger capacity; and a combination of these two is being exploited in Europe, but the fact that practically everyone in this country who is working on a locomotive to be operated with Diesel engine is using the electric system of transmission, indicates that there are serious limitations to the mechanical and hydraulic systems and that the great superiority of the electric is generally accepted.

Similarity of Diesel-Electric to Motor Generator Type Electric Locomotives

The Diesel-electric locomotive is similar in its characteristics, performance and equipment to the motor-generator type of a. c. locomotive which has been recently developed. The motor generator type locomotive takes power from a single phase trolley and utilizes a synchronous motor to drive a direct current generator which generates the current for the driving motors. The Diesel-electric substitutes the engine with its auxiliaries for the synchronous motor, transformer and all other parts of the equipment pertaining to them. The equipment from and including the direct current generator to the motors is or may be practically the same. Speed regulation is by voltage control of the generator in both cases. The motors for both are low voltage, direct current series machines, with all of their rugged characteristics. The main difference between the Diesel-electric and the motor-generator type lies in the fact that the output of the Diesel engine is limited to a very definite value which may be carried for long periods while the synchronous motor with the same continuous rating, has a great power house back of it and may carry very heavy overloads for short periods. The Diesel-electric in this respect has almost the same limitation as the steam locomotive. Its horsepower capacity is limited. It can exert the same maximum tractive effort as the all-electric because of the motor drive, but only at very low speeds.

Desirable Features of the Electrical Equipment

On a Diesel-electric locomotive, the generator and motors must be considered as a unit in calculating the output of the locomotive. The most important features of the electrical equipment are:

1. The ability to utilize the full capacity of the engine at whatever train speed it is needed or desired.
2. A high efficiency so as to transmit the maximum amount of energy from the engine to the wheels.

3. Simplicity of control.
4. Light weight.

What are the characteristics of the electrical equipment that will best utilize the engine capacity? Voltage control of the generator has already been mentioned as giving the maximum flexibility for control of speed and tractive effort. This, however, is operative only up to the normal voltage of the generator and over most of the range while overloading the motors and generator. Over-voltages are sometimes secured by forcing the generator field. Where the voltage is limited as is necessarily the case with a generator designed for a definite voltage, further speed control may be secured by weakening the fields of the motors and there is no reason why a very considerable range of speed cannot be covered in this way.

It may be said that there will be serious difficulties from commutation of the motor at weak fields and high speeds. This might be serious with motors taking current from a trolley with all its fluctuations and surges in voltage but it is much less serious where the power plant goes with the motors. Special care must of course be taken to secure the best adjustment of the commutating field for high speeds. This is purely a matter of good design. It must be remembered that neither generator nor motor is over-loaded while operating with weak fields on the motors.

Series parallel control is advantageous in some classes of service. A locomotive which is ordinarily used for road service will operate more efficiently at low speeds if the motors are connected two in series. It is the practice with some gas-electric and Diesel-electric cars, and locomotives also, to start the train with motors in series and change to parallel after gaining some speed. This, however, either requires a complete cutting off of power during the transition or a more complicated control system. While the series parallel connection is useful, it is desirable to avoid it if possible. The advantage of series operation lies in the greater efficiency at heavy loads on account of the decreased generator current.

Efficiency

It can readily be seen that the efficiency of the electrical equipment is of the utmost importance, not simply on account of the fuel consumption but because the higher the efficiency the greater will be the energy of the locomotive available at the wheels. Every effort should be made to make it as high as possible. The electrical equipment, when properly designed, will have an excellent all-day efficiency.

Simplicity

With all of the complications of the Diesel engine and its auxiliaries to contend with, it is all the more necessary to have a simple electrical control system and it is fortunate that there are a number of ways to secure this feature. The one most commonly used provides an automatic control of the generator voltage which limits the output of the generator to the capacity of the engine so that the engine is in no danger of being stalled. This is usually combined with engine speed control. It is very desirable with the Diesel engine to keep the speed as low as possible for the output that is required, as low speed means lower maintenance, and especially lower consumption of lubricating oil, which is usually one of the most expensive items of operation. It is fortunate that this idea of variable engine speed combines very readily with a good control system for the electrical equipment.

Auxiliaries

The auxiliaries on a Diesel-electric locomotive are like the auxiliaries on other kinds of locomotives—very important and very annoying. The Diesel engine requires pumps for water circulation and for lubrication. It requires air filters and radiators with a thorough ventilating system for cooling the engine. There must of course, be ample capacity of air compressors for the brakes and control and these are preferably driven electrically, either from the main generator or from an auxiliary supply system. Means must be provided for starting the engine and this is a matter of the greatest importance since if the engine cannot be started, it is useless. It is usually started by compressed air, a pressure of from 200 to 500 pounds being necessary. In some cases the engine is started by current from a storage battery using the generator as a motor. Of course, a comparatively small amount of control equipment for the electrical apparatus will be necessary but the sum total of the auxiliary equipment amounts to quite a large proportion. The last but by no means not least requirement is a good supply of fuel, oil and water.

Weight

Diesel locomotives that have been built thus far range in weight per hp. from 207 lb., which was practically the first locomotive built, to 400 lb. The largest locomotive built in this country to date is the 1,000 hp. Diesel-electric built by the Baldwin Locomotive Works, with electrical equipment manufactured by the Westinghouse Electric & Manufacturing Company. This weighs 275 lb. per hp. It is probable that it will be some time before locomotives weighing less than 200 lb. per hp. can be built regularly with Diesel-electric equipments. The engine itself varies tremendously in weight, depending very largely on the builders and the type of engine adopted. Engines weighing 50 to 75 lb. per hp. are more or less common. There are now builders in the field who manufacture Diesel engines for locomotive use, weighing 16 lb. per hp. for a 340 hp. engine. Such an engine has been built by the Beardmore Company in Great Britain and two of them are operating on articulated cars in Canada on the Canadian National Railways.

The fact that the engine itself weighs only 16 lb. or less does not of course cover the entire situation. Sixteen pounds out of 200 is not a very large proportion. When the auxiliaries required by the engine and the mechanical parts of the locomotive necessary to house and carry an engine of large capacity are included, together with fuel and water and the electrical equipment, it means a sum total that is far beyond what would ordinarily be thought necessary. As a matter of fact, the weights are pyramided. The Diesel engine pyramids weight very rapidly, due to its large dimensions which require space in the cab, and a firm foundation for the alignment of the engine and generator.

Therefore, when I give 200 lb. per hp. as the low limit for the Diesel-electric locomotive, I give a figure which has never yet been attained and which will require all of the ingenuity and refinements available to secure it. For the present, it is much safer to figure on a weight of 250 to 300 pounds.

The Field of the Diesel-electric

Now, what is the field of the Diesel-electric locomotive? Is it going to displace all of the steam locomotives and eliminate the electric from further consideration? It is quite unnecessary for anyone in the steam or electric locomotive business to be alarmed at this time. Samuel M. Vauclain has said that much time will elapse and many millions of dollars be expended to develop the Diesel-electric locomotive to a point where it will figure to any great extent in transportation service. Mr. Vauclain is probably right so far as trunk line service is concerned, but the Diesel-electric locomotive undoubtedly will have a definite field in transportation circles. The first and probably the most important field will be on branch lines of railroads in service such as the Canadian National Railways are handling with their Diesel-electric cars. Switching is another field which is a most desirable place for Diesel-electric. The ordinary steam switchers used around buildings are a great nuisance on account of the noise, smoke, and dirt which they disseminate. They are also expensive to maintain. The Diesel-electric eliminates

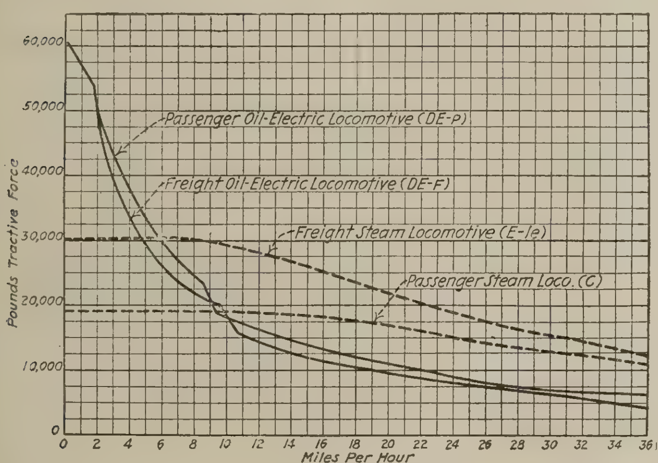


Fig. 2—Tractive Force—Speed Characteristics of Two Diesel-Electric Locomotives Being Built for the New York Central and Similar Curves for the Steam Locomotives Which Will Be Replaced by the Diesel-Electrics

a great part of the nuisance, is able to stay on the job for many hours at a time and probaly will require little maintenance when it is taken to the round house. These features, together with the flexibility of the electric transmission and the fuel economy make a most desirable successor to the steam locomotive. It is preferable in some situations in large cities to the electric switcher, since it eliminates the necessity for the overhead wires or third rail which are extremely difficult to apply in and around buildings and represent a high investment from which little return is possible.

The Diesel-electric will probably find a certain field in main line service, especially for slow speed freight haulage, where the weight per hp. is no particular disadvantage. It will be particularly useful in this respect on branch lines where the traffic is comparatively light. Further than this, no one can speak with any degree of certainty at this time. There may be local conditions where the fuel economy of the Diesel-electric alone will make it economical for operation on long runs, even with high speeds, but in general it is not probable that it will be used to any extent for other than slow speed traffic for some years to come.

There is one point concerning it which cannot be too often emphasized:—its use does not eliminate the fundamental limitation of the steam locomotive, namely, that its power is limited to the amount that can be generated on the locomotive itself, while the electric always has all the power it can utilize.

Electrification

Electrification will go forward in terminals and on the railways having heavy traffic where the investment in overhead lines and substations does not represent a considerable part of the cost of electrification. The Diesel-electric and the straight electric locomotive will move side by side in improving the transportation of the railways of the world. The steam locomotive will still roll along for many years as it has advantages which are hard to overcome. It must be understood, however, that the steam locomotive is not the simple machine it once was. The improvements which have so greatly increased its capacity and efficiency have made it a very complicated machine and one which is most difficult to maintain. These are the reasons which will ultimately compel the retirement of a large part of them in favor either of the all-electric, the Diesel-electric or some other independent type of locomotive.

Discussion

The discussion was opened by E. B. Katte, chief engineer, electric traction, New York Central. Mr. Katte said, "The most promising field for the Diesel locomotive is in switching service in non-electrified yards, or between yards operated under different systems of electrification. Also on railroads with relatively infrequent service, or on branch lines where the traffic is not heavy enough to provide an operating saving sufficiently large to cover the increased fixed charges on the cost of electrification. To successfully compete in either of these fields the Diesel locomotive must operate practically noiselessly and smokelessly; the economy in operation must at least equal that of the electric locomotive and the first cost must be less than the combined cost of the electric locomotive and the working conductors."

He said further that tests of Diesel-electric locomotives made on the New York Central show that a locomotive larger than 300 hp. is needed. We would like, he said, to have a 1,000 hp. locomotive weighing 100 tons. In concluding his discussion he described two Diesel-electric locomotives now being built for the New York Central and showed speed tractive power curves for these and the steam locomotives they will replace. One will be a 750 hp. freight locomotive with a maximum speed of 40 m.p..h. weighing 256,000 lb. The other will be an 800 hp. passenger locomotive with a maximum speed of 60 m.p.h. weighing 296,000 lb. The type E-le steam freight locomotive weighs 157,100 lb. and the type C steam passenger locomotive weighs 160,000 lb. The tender in each case weighs 108,000 lb. loaded.

W. B. Potter, chief engineer, railway department, General Electric Company, spoke of Diesel-electric locomotives as a unit form of electrification and said he believed the Diesel-electric would favorably effect ultimate electrification.

Sidney Withington, electrical engineer, New York, New Haven and Hartford, pointed out the fact that the Diesel-electric locomotive is very young while the steam locomotive is 100 years old and the electric 30 years old. He

stated that his experience showed that the reliability of electric motive power is greater than steam in spite of the fact that it must rely upon the integrity of the power plant. The shopmen's strike in 1922, he said, also demonstrated that electric locomotives could be maintained by unskilled men. The same, he said, is probably also true of Diesel-electric locomotives. He spoke also of the need for a standard system for electrification and in response to a statement by a previous speaker said that the danger of an electrified system can be overcome by education.

To show how unlikely it is that the Diesel-electric locomotive will replace the electric for heavy service he cited the case of the Virginian on which road two locomotives apply 20,000 hp. to a train on starting. The total cost of Diesel-electric locomotives for large power requirements, he said, would be twice that for straight electric. He stated also that oil costs may change the status of the Diesel locomotive. He considers the Diesel-electric locomotive particularly suitable for wrecking train service as it is ready to go at any time without getting up steam and can travel under a dead wire.

W. S. Murray, consulting engineer, concluded the discussion by saying that the mechanical effort to move a train by any means is the same and there is no need to fear that electrification will be supplanted by the Diesel-electric locomotive.

Diesel-Electric Tugboats for the New York Central

TWO Diesel-electric tugboats for operation in New York harbor have been ordered by the New York Central and will probably be put in operation this summer. Factors influencing this decision were economy, simplification and ease of control and other advantages attendant upon the use of electricity. The boats will be built by the Staten Island Shipbuilding Company at Staten Island and were designed by J. W. Millard & Brother, naval architects, New York. The complete electrical equipment will be supplied by the General Electric Company.

Each boat will be 108 ft. long with a maximum width of 26 ft. The Diesel engines and electric generators will be located amidships, while the propulsion motor will be installed aft and will be direct connected to the propeller shaft. The fuel oil storage tank will be located forward.

Power for driving the generators will be furnished by two Diesel engines on each boat, one set built by the Ingersoll-Rand Company, and the other by the McIntosh & Seymour Corporation, Auburn, N. Y. Each engine will be a six-cylinder machine operating on a four-stroke cycle, rated 400 brake horsepower. The Ingersoll-Rand engine will run at a speed of 265 r. p. m. and the McIntosh & Seymour engine at 300 r. p. m. Each Diesel engine will be direct connected to a General Electric direct current generator rated 270 kilowatts and 240 volts. The propelling motor for each boat will be a 650-horsepower, 115/145 r. p. m., 480-volt direct current motor of the shunt wound, double armature type. This motor, when connected in series with the two main generators, will be capable of delivering 650 shaft horsepower to the propeller shaft at any speed from 115 to 145 r. p. m. In addition to the main generators, each boat will be equipped with two auxiliary generators, each rated 30 kilowatts, for furnishing power for excitation, lighting and for operating auxiliaries. These generators will be mounted on a shaft extension of the main generators.

One of the features of the boats will be a 75-horsepower fire pump on each, to be electrically driven, power being supplied by either of the main generators. Control of the boats will be from the pilot house and will be of the Ward-Leonard type.

A Fruit Train on the South African Rys.

View of Kansas City Union Station

Car Lighting at the Kansas City Terminal

System of Recording Time and Materials Used in Maintaining Various Equipments Is a Great Aid in Accounting

By W. J. Dawson
Chief Electrician, Kansas City Terminal Ry. Co.

THE handling of the maintenance and repair of the electric train lighting equipment at a joint terminal, in a satisfactory manner, as regards the continuity of good service, and the rendition of such service at a minimum cost, is a service of no mean importance to both the managements of the railroads and the traveling public, and one which is worthy of considerable thought and mention.

The majority of passenger train cars today is equipped with straight electric light systems, i. e., no gas or other auxiliary system, except candles, to depend on for light, should the primary system fail to function properly.

Car lighting at the Kanas City Terminal is similar to that at any other terminal, insofar as the handling of these details is concerned, but the fact that practically every type of train lighting equipment that was ever developed is operating into this terminal, and that each of our tenant lines has standard practices of its own, necessitates an organization for handling the work and methods of accounting that differ in many respects to those of trunk line terminals, or yards, where the equipment of one road only is serviced.

Twelve trunk-line railroads operate approximately two hundred and twenty-five trains daily, which arrive and depart from the Kansas City Terminal Union Station.

All trains of the following nine railroads are serviced entirely by our forces in two coach yards, of fifty-three tracks, located one-quarter mile west of the Union Station: Chicago, Burlington & Quincy; Chicago, Rock Island & Pacific; Chicago Great Western; Chicago &

Two Views of the Coach Yard at Kansas City Terminal

Alton; Missouri Pacific; Missouri-Kansas-Texas; Kansas City Southern; Union Pacific; Wabash.

The railroads using the Union Station, but not the coach yard facilities, and to whom emergency electrical protection is extended on out-bound and passing trains are: Atchison, Topeka & Santa Fe; Chicago, Milwaukee & St. Paul; St. Louis-San Fransisco.

A car lighting force of eight-hour shifts is maintained to handle an average of two hundred and fifty electrical departures daily, and the Terminal Company organization has often been compared to that of a garage servicing railroad trains, instead of automobiles.

The trains are taken charge of immediately upon arrival at the Union Station by Terminal Company forces and as soon as the passengers and crews are detrained they are handled out of the Union Station by Terminal Company engines and crews, turned on the "loop" and piloted into the coach yards.

The electrical equipments are then tested and necessary repairs or adjustments extended, according to the requirements and standard practices of the respective owners. A series of routine tests and inspections is made, regardless of whether the owners require adjustments or repairs. This is done for the benefit of record.

The entire electrical force is kept posted, at all times, on the requirements, or standard practices, of the various tenant railroads and also on changes as are requested from time to time by the owners. By so doing, we have


KANSAS CITY TERMINAL RAILWAY COMPANY

Car No. Initial Kind Date 192

BAD ORDER

SET TO

REPAIR TRACK

DEFECTS

Received From Inspectors

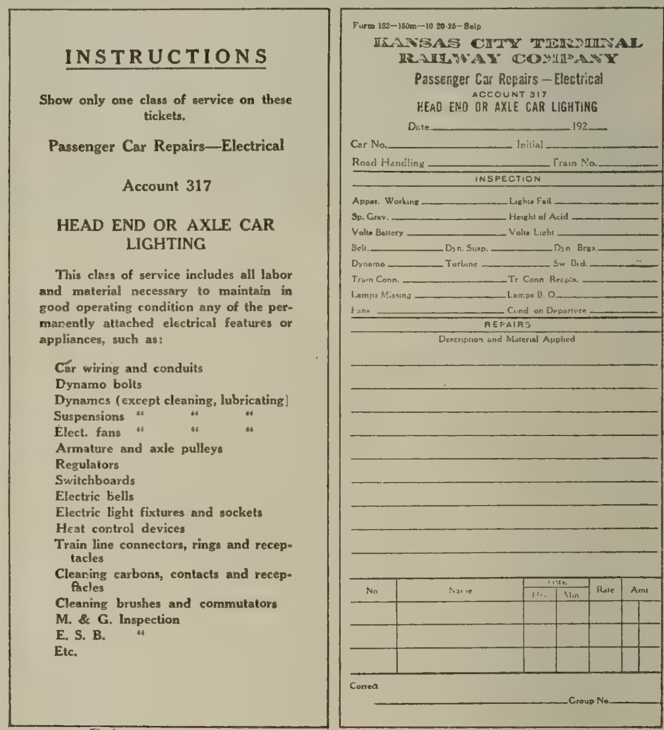
CAR No. INITIAL KIND Date 192 PASSENGER REPAIRS

REPAIRS MADE | Weight | Why Made | Date 192 | Car No. | Initial | Charge to | Train No. | No. | Names | Hrs. | Rate

Fig. 1—The Illustration Shows the Face and Back of the Bad Order Card—the Original Measures 3¾ in. by 8⅞ in. and is Printed With Red Letters on a Manilla Card

no "specialists" on the equipment of any one railroad. This condition is especially advantageous on Sundays and days of short help, in that the force is "flexible" and enables the supervisor to use his men to advantage on any of the trains with the knowledge that his men are equally as good on head-end turbo-generators as on axle generators, or as familiar with regulator inspection and repairs, as battery flushing or charging. Of course, our force is organized along lines of regular "runs," but in no instance do we have a man who is familiar with the requirements of only one class of equipment.

The battery men are the first to inspect the cars. The light load is switched on and the battery is inspected for flushing, leaky cells, bad connectors, specific gravity reading, and all visible evidence of defects. The voltage readings of battery and light are taken at the distribution panel by use of a model 280, double range, 0-8/0-80, portable voltmeter. Should this inspection reveal readings out of step, or indicate the necessity of a charge, or an individual cell voltage reading, flushing, or other repairs, this information is left in the electric locker for the benefit of the electrician making inspection of the


INSTRUCTIONS

Show only one class of service on these tickets.

Passenger Car Repairs—Electrical

Account 317

HEAD END OR AXLE CAR LIGHTING

This class of service includes all labor and material necessary to maintain in good operating condition any of the permanently attached electrical features or appliances, such as:

Car wiring and conduits
Dynamo bolts
Dynamos (except cleaning, lubricating)
Suspensions " " "
Elect. fans " " "
Armature and axle pulleys
Regulators
Switchboards
Electric bells
Electric light fixtures and sockets
Heat control devices
Train line connectors, rings and receptacles
Cleaning carbons, contacts and receptacles
Cleaning brushes and commutators
M. & G. Inspection
E. S. B. "
Etc.

KANSAS CITY TERMINAL RAILWAY COMPANY

Passenger Car Repairs—Electrical

ACCOUNT 317

HEAD END OR AXLE CAR LIGHTING

Date 192

Car No. Initial

Road Handling Train No.

INSPECTION

Appar. Working Lights Fail
Sp. Grav. Height of Acid
Volts Battery Volts Light
Belt Dyn. Susp. Dyn. Brgs.
Dynamo Turbine Sw. Brd.
Train Conn. Tr. Conn. Recpts.
Lamps Missing Lamps B. O.
Fans Cond. on Departure

REPAIRS

Description and Material Applied

No. | Name | Time | Rate | Amt.

Correct Group No.

Fig. 2.—The Form Shown at the Right Measures 3½ in. by 7¾ in. and is Printed With Black Letters on White Paper—These Forms are Made into Pads the Cover of Which Bearing Instructions, is Shown at the Left

balance of the equipment, and the work is turned over to another battery charging and repair man for completion.

Incidental to the above inspection, the battery compartments are closely watched for an unusual accumulation of dirt or sulphate. A clean compartment, a battery well blocked to prevent shifting of the trays in the compartments, cells with solution at proper level to prevent slushing out while on the road, and vent caps properly placed, are considered very important features in our routine of battery maintenance. A lamp and socket are used in connection with a suitable funnel when flushing to indicate when distilled water has been added to the proper level.

The storage battery and the personnel of the organization held responsible for its maintenance can truly be termed "the heart of the electrical car-lighting system," and the service to the traveling public is in direct proportion to the standards at which these are maintained.

The generator and regulator men are the next to make inspection of their respective features of the equipments. Should the battery and voltage readings, as left by the battery inspector, indicate below normal, immediate check is made to ascertain the cause and steps are taken to

correct any irregularity found to exist. These men are drilled to look upon light failures with disdain and through careful inspection and maintenance of detail prevent their actual happening. "A stitch in time saves nine," and complaints and correspondence are thus reduced to a minimum.

The generator belts are slackened each trip and the machines are given the "motor and generator" tests. While these tests are being made, the commutator and brushes are checked for wear and unhealthy sparking.

INSTRUCTIONS

Show only one class of service on these tickets.

Train Supplies and Expenses—Electrical

Account 402

HEAD END OR AXLE CAR LIGHTING

This class of service includes all labor and material necessary to replace the consumable portions of the electrical equipment, supplies for protection of operation and such other items as:

Electric light bulbs
Fuses
Supplies (except train connectors and rings)
Tools in supply lockers
Shades or reflectors
Cleaning dynamos and switchboards
Oil and Waste
Cleaning and lubricating fans
" " " dynamos
" " " suspensions
Adv. signs, cords, etc.
Putting up and taking down connectors
Turning off lights
Starting head end dynamos
Testing and setting regulators,
Etc.

Form 15—100m—10-20-25—Selp

KANSAS CITY TERMINAL RAILWAY COMPANY

Train Supplies and Expenses Electrical

ACCOUNT 402

HEAD END OR AXLE CAR LIGHTING

Date ______ 192 __

Car No. ______ Initial ______

Road Handling ______ Train No. ______

TRAIN SUPPLIES AND HANDLING EXPENSES

Condition of Advertising Sign ______

Description and Material Applied

No.	Name	TIME Hrs.	TIME Min.	Rate	Amt.

Correct ______ Group No. ______

Fig. 3—This Form is Same Size as Fig. 2—It is Printed on Yellow Paper and is Made in Pads With Cover as Shown

The pole-changer and connections are inspected, and the bearings are checked for wear and unusual noises, or knocks. The ball bearing grease dates are closely checked and the bearings greased according to requirements of the owners. The dynamo leads from the terminal points are kept taped and shellaced, and each lead is allowed to swing independent of the others. This practice eliminates the possibility of a broken lead caused by the short lead sustaining all strains.

The dynamo suspensions are carefully inspected for worn or defective parts and the supporting pins and bushings are lubricated at frequent inspections. The pulleys are checked for proper crown and alignment, and the belt is inspected at the fasteners for cracking and brake rigging clearance. Should more belt clearance be needed, or should the steam drip shields be missing, or defective, the electrician fills in a Bad Order card, Fig. 1 and hands it to the supervisor, who, in turn, hands it to the proper repair man for correction. On the reverse side of this form, the mechanic completing the repair makes entry of time and material consumed. These forms are filed in support of the bill rendered the tenant road. The electrician makes suitable notation on his reports, as explained later. The Safety Company belt fasteners are used in all cases where clearances will permit.

Upon inspection of the apparatus inside the car, particular attention is given to the voltage loss beween the battery and lamps, and necessary repairs, or adjustments, in lamp regulators are made to bring this loss to a minimum. Lamp regulator "setting" is accomplished by making adjustments with the battery on charge at approximately 38 volts.

Moving parts on the regulators are carefully checked for excessive mechanical resistance, and all pins are kept clean and free from grit or gum. Oil is not used on these parts, thus preventing accumulation of dust, and no sand paper or emery cloth is used on the pins, which practice would tend to reduce their diameter and create an undesirable condition.

The automatic switch is in reality an automatic reclosing circuit breaker with no-load and reverse current features, intended to function at the most critical moments during the cycles of equipment operation, and for which reason its mechanical and electrical operation cannot be checked too closely. By so doing, we reduce the number of burned carbon and copper contacts, as well as equipment failures.

The fuse clips and contacts are likewise kept clean and

INSTRUCTIONS

Show only one class of service on these tickets.

Train Supplies and Expenses—Electrical

Account 402

BATTERY CHARGING AND RENEWALS

This class of service includes all labor and material necessary to replace the consumable portions of the storage battery, such as:

Charging current
Flushing
Distilled water
Acid
Negative and positive groups
Separators
End and side liners
Etc.

Form 176—50m—10-20-25 - Selp

KANSAS CITY TERMINAL RAILWAY COMPANY

Train Supplies and Expenses—Electrical

ACCOUNT 402

BATTERY CHARGING AND RENEWALS

Date ______ 192 __

Car No. ______ Initial ______

Road Handling ______ Train No. ______

CHARGING

Time on	Time off	Ampere Rate	[illegible]	[illegible]
M	M			
M	M			

RENEWALS, FLUSHING, ETC

Description and Material Applied

No.	Name	Time Hrs.	Time Min.	Rate	Amt.

Correct ______ Group No. ______

Fig. 4—This Form is Same Size as Fig. 2—It is Printed on Pink Paper and is Assembled in Pads the Same as the Others

light and fuse failures, due to excessive heat, rather than overload, are minimized.

The resistance units are heated to ascertain whether the circuits are closed and checked to see that the proper units are in circuit. The field carbons are inspected and cleaned every ten days or two weeks, and burned or pitted discs replaced. A record of cleaning dates is maintained.

Where required, extra fuses are maintained in the electric lockers for protection of the equipments on the road, and beside the usual inspection of the lamps, fixtures and fans, a careful check is made of the train line connectors and receptacles to see that the fingers and contacts are clean and divider fingers in good condition. A train

line connector, when needed on the road is usually the last expedient and then and there is when it needs to be in a serviceable condition. Train lining equipment, maintained in good order, is considered to be cheap lighting insurance.

In order that the various charges made for labor and material against the individual cars can be divided and grouped under the proper general headings of the Interstate Commerce Commission's classifications, Passenger Car Repairs, Account 317, and Train Supplies and Expenses, Account 402, a unique system of forms and reports has been adopted. This enables our accounting department to prepare and render the bills to our tenants for these various services in such manner as will enable the tenant road accounting departments to make the proper distribution of charges through their accounts.

To simplify this handling as much as possible and furnish records for all concerned, four forms, printed on vari-colored paper, are used. Figs. 2, 3, 4, and 5 show these forms, which are white, yellow, pink and green, respectively. The forms are printed in pads of one hundred sheets each, with instructions printed on the cover of each pad as to its respective use, also, as shown in Figs. 2, 3, 4 and 5. By use of the different colors, we find it aids materially in familiarizing and guiding the electricians in making their reports, as well as assisting the accounting department in sorting and compiling the charges under the proper headings.

These reports are made in triplicate by the electricians performing the inspection or repair, the original of which accompanies the bill to the tenant road in support of the charges made therein. One copy is furnished the electrical department of each road concerned for its use in checking performance of equipment and compiling necessary data and records. One copy is filed for record.

A 4 in. by 8 in. card-index filing system is used, with an index card for individual cars in separate sections for the different roads. These reports are maintained in date or trip order for a period of one year, at the end of which period, they are bundled and marked for filing in the record department.

It seldom happens that all four forms are made out for any one car. Quite frequently two and three of the forms are made but the white form, Fig. 2 is always made out on each car inspected. Provision is made in the working of this report so that a complete record of the condition of the car equipment will be rendered by the inspector, whether the car is equipped with axle

INSTRUCTIONS

Show only one class of service on these tickets.

Passenger Car Repairs—Electrical

Account 317

BATTERY INSPECTION AND REPAIRS

This class of service includes all labor and material necessary to maintain in good operating condition any of the permanently attached electrical features or appliances, such as:

INSPECTION

Specific gravity readings
Voltage reading
Inspection of general condition

REPAIRS

Service leads
Lead or rubber jars
Trays, handles, skids, etc.
Connectors and bolts
Covers and bushings
Sealing compound
Lead insulating boards
Space boards
Changing batteries
Battery box, floors and doors
Cleaning and painting
Acid resisting paint
Binding posts
Etc.

Form 22—20m—10-20-25—Scip

KANSAS CITY TERMINAL RAILWAY COMPANY

Passenger Car Repairs—Electrical

ACCOUNT 317

BATTERY INSPECTION AND REPAIRS

Date ________ 192__

Car No. ________ Initial ________

Road Handling ________ Train No. ________

INSPECTION

Train Numbers ________

REPAIRS

Description and Material Applied

No.	Name	Time Hrs	Time Min	Rate	Amt.

Correct

________ Group No. ________

Fig. 5—This Form is Also Same Size as Fig. 2—It is Printed on Green Paper

device, head-end or storage battery system. The yellow form, Fig. 3 accompanies the white form whenever any of the operating services are performed, as listed.

The pink form, Fig. 4 is made by the battery men, covering services rendered, as listed also, and shows complete record of charging rate, switchboard voltage and kilo-watt hours. The green form, Fig. 5 is likewise made out covering labor and material incidental to the maintenance of the batteries, as listed.

KANSAS CITY TERMINAL RAILWAY COMPANY

CAR DEPARTMENT Requisition on Storekeeper

For Tenant Road Equipment Only

Date ________ 192__

Storekeeper will show date of issue and store from which issued, in this space. **Req. Nº 92154**

Charge to ________
(Road Handling This Equipment)

Car No.

Initials ________ Name ________ Arrived in ________ Train No. ________ of ________ 192__
(Name of Road) (Date)

DRAW ITEMS OF ONE CLASS ONLY ON THIS REQUISITION

Quantity	Description of Material	Material to be Applied—Charge: Unit	Price	Amount	Class	Material Recovered—Credit: Weight	Price	Amount	Class

FOR USE OF STORE DEPT.

Delivered by Priced by

Foreman. Workman.

Fig. 6—This Form Measures 3½ in. by 8½ in. It is Made up With Carbon Back so That Three Copies Can be Made at Once

All items of material drawn from the storehouse are listed on these forms and the distribution of labor expended is shown in the space provided. The total distribution of each man's time throughout these reports is checked to tally with the total time shown on his clock card, stamped at the beginning and end of his daily working period. The payroll is made up from the clock cards and the Terminal Company is reimbursed through bills rendered the tenant roads and supported by the job tickets. Each job and report is checked for correctness and approved by the supervisor.

The requisition on storekeeper, Fig. 6, is made out covering items of material drawn and applied to the cars. This form is printed in carbonized-back, fan-fold effect, and after the price is extended it is used by the Accounting Department, the original of which accompanies the compiled bill, in support of the charges therein.

All forms submitted the tenant roads are such that counter-bills against foreign line car owners can be rendered in accordance with A. R. A. Rules.

Form 225—1m—8-24-25—Seip

KANSAS CITY TERMINAL RAILWAY COMPANY

Condition of Head-End Dynamos Leaving Union Station. Date__________192___

ROAD	Train Number	Engine Number	Dynamo Car Number	Steam Pressures		Voltage Readings		Ammeter Readings			INSPECTOR
				Dynamo	Train Heat	Battery	Lights	Battery Load	Light Load	Total	

REMARKS:

USE OTHER SIDE FOR ADDITIONAL REMARKS

Fig. 7—This Form is 5½ in. by 8½ in. Printed on White Paper

Another feature of our system or records is, that in all cases, the initial record originates in the handwriting of the individual performing the services.

Such items of material as can be purchased on the open market, at a figure lower or equal to that at which the railroads could furnish them, are so purchased. The

Car Lighting Force, Kansas City Terminal—From Left to Right—Top Row—V. R. Ayer, V. J. Nicholson, R. M. Johnson, O. Sargent, P. Brooks, L. Clark, W. O. Justice, F. E. Bradley—Middle Row—W. J. Dawson, R. E. Leppert, J. C. Ramirez, G. Robinett, B. O. White, Jas. Forster, F. B. Ford, J. R. Fulton—Bottom Row—F. W. Lehman, H. D. North, E. A. Clouse, L. Nicholson, G. W. Waterman, R. R. Geddes, F. Stucker

storehouse stock is maintained much the same as on a trunk line railroad and all material applied to the cars is in accordance with the requirements or standard practices of the car owners to whom it is issued.

Through close co-operation between the Store and Electrical Departments, the stock is kept at a working minimum, and slow moving or obselete items, are not allowed to accumulate. Thus, the amount of money tied up in this class of material, which is usually very expensive, is as low a figure as possible.

Reclaimable scrap material removed from the cars is returned to the owners, or credit is allowed, and only such items as armatures, batteries or other materials, peculiar to the equipment of the individual road, are requisitioned from the tenant lines for replacement of worn or defective parts.

The steam turbines and generators on roads using the head-end system of lighting, are tested each trip during the lay-over period. Condition of the governors is checked for operation and load carrying capacity, and the bearings and oiling systems are carefully inspected for wear and to ascertain that the oil is circulating through the system freely and at the proper pressure. A small amount of oil is drawn from the bottom of the reservoirs to see that the oiling system has not filled with water from condensation, leaving only small amount of oil on top. The oil is changed at regular intervals, per requirements of the owners.

The steam piping and fittings are checked for leaks and asbestos lagging kept in repair. Necessary steps are taken to prevent losses through leaks and condensation.

Fig. 7 shows the form made out by the electricians starting the dynamos at the Union Station at the time of turning the trains over to the train-electricians for handling on the road. These forms are filed as a matter of record.

Pennsylvania to Build Eight Electric Locomotives

Six electric passenger locomotives and two electric switching locomotives are to be built by the Pennsylvania. Contracts for the motive machinery, controls and other electrical equipment have been awarded to the Westinghouse Electric & Manufacturing Company. This equipment will be shipped to the Juniata shops of the Pennsylvania System at Altoona, where the entire group of eight locomotives are to be built.

The six passenger locomotives with a continuous rating of 3730 horsepower each will be put into operation on the New York division hauling heavy passenger trains between the Pennsylvania Terminal in New York City and Manhattan Transfer. These locomotives are in addition to two others of a similar type placed in service at Manhattan Transfer in 1924. The locomotives were designed by the engineering staff of the motive power department, Pennsylvania Railroad, under the personal direction of its chief, J. T. Wallis. When delivered and ready for service, each locomotive will weigh approximately 400,000 pounds and will have a total length of 68 feet. The passenger locomotives have a 2-8-2 wheel arrangement with the so-called "Steeple" type cab construction. The motors are arranged two per jack shaft, and are mounted outside, and at either end, of the driving wheelbase. Each jack shaft serves two pairs of drivers, the latter of which are 80 in. in diameter. The connection between the motors and the jack shaft is by means of pinions and flexible gears. The gear ratio of the locomotive is designed so that it will permit of operation at a sustained speed of 70 miles an hour.

The two electrical switching locomotives are of the so-called double-cab type for general yard work, of which quite a number already have been ordered.

The American Brown Boveri Electric Corporation has acquired two additional properties, namely the Railway & Industrial Engineering Company of Greensburg, Penn., and the Electric Development & Machine Co. of Holmesburg, Penn., near Philadelphia. These latest acquisitions will considerably amplify the present line of American Brown Boveri electric products. In addition to the newly acquired properties, the corporation also has in operation its plants at Camden, as well as those of the Condit Electric Manufacturing Company, Boston, the Scintilla Magneto Co., Sidney, N. Y., and the Maloney Electric Company, St. Louis. The newly acquired companies specialize in high tension switching and protective equipment for power companies. They will be operated as distinct units in the American Brown Boveri group and their production will supplement that of the other units of the corporation.

One of the Pennsylvania Type L-5 Locomotives Used in the New York Terminal. The New Locomotives Will Be of This Type

A "1 — C + C — 1" Express Passenger Locomotive of the Chilean State Railways

Electric Locomotive Classification

New System Proposed Which is Simple and Does Not Have Limitations of the Whyte System

By David C. Hershberger
General Engineer, Westinghouse Electric & Manufacturing Company

THE wheel and truck arrangement of an electric locomotive may be briefly indicated by a logical system of symbols, letters and numerals in proper arrangement.

It is desirable that such a system be so arranged that the classification information may be conveyed by either verbal or written means. This has been accomplished in steam locomotive practice by several systems, but the one most generally used by the American railroads is that originally proposed by F. M. Whyte.

The Whyte system has also been used for classifying the wheel arrangement of electric locomotives but has not proven satisfactory even when applied in modified form. The classification of the wheel and truck arrangement of electric locomotives is not as feasible with this system as with a system, using numerals, letters and signs. This is brought about by the fact that with electric motors a wide range of flexibility in wheel arrangement as between drivers and ponies, or guiding wheels, is possible, that handicaps the Whyte system, which was designed primarily for steam locomotives in which there is a more or less fixed relation between cylinder location and driving wheels.

One of the first mental acts performed by one viewing a locomotive or its photograph, is that of counting, the number of axles rather than the number of wheels. Therefore, the most simple method is that of designating the number of axles instead of the number of wheels, which eliminates the effort of considering two wheels per axle. The next feature considered is that of the number of driving axles as compared with the number of guiding and idle axles. In the Whyte system, numerals are used to represent both driving and non-driving axles which leaves more to the imagination than with a new "Standard System" using numerals for indicating non-driving axles and letters for driving axles.

The system here described is that tentatively accepted by the manufacturers of electric locomotives in the United States and is a modification of that used by continental European manufacturers.

Starting at the front end of locomotives designed for single end operation or at either end of engines built for double end operation, the wheels and truck connections are designated in their consecutive order. The letters represent the driving axles, the numerals the guiding or carrying axles and the signs the absence or presence of connection between trucks.

1. The number of adjacent driving axles (a) in a rigid wheelbase, or (b) on a truck, is represented by a letter selected according to its alphabetical order. Examples: B—Two driving axles. C—Three driving axles, etc.

2. The number of adjacent idle (non-driving) axles in a rigid wheelbase or a truck is represented by an arabic numeral. Example: 1—One idle axle. 2—Two idle axles, etc.

3. Trucks having both driving and idle axles in the same rigid wheel-base are designated by a letter and a numeral placed together in proper order. Example: 1-A —Truck with one idle and one driving axle. 1-B—Truck with one idle and two driving axles.

4. The connection between trucks or motive power units, constituting an articulated joint (a flexible connection through which propelling forces are transmitted to the drawbars) is indicated by a plus (+) sign. Example: B + B — Two trucks connected by an articulated joint.

5. The separation between swivel type trucks is represented by a minus (—) sign. Example: B — B — Locomotive with two swivel type trucks.

The separation between a rigid base of any group of main driving wheels and adjacent guiding or carrying

trucks not connected through an articulated joint is represented by a minus (—) sign. Example: 1 — D — 1, a locomotive with a guiding truck at each end, and four driving axles in a rigid wheelbase in the center.

When two or more motive power units with duplicate wheel arrangements are operated in multiple as a locomotive, the number of units is indicated by a numeral preceding the regular classification of one unit put in parentheses. Example: 3 (1 — D — 1)—Three unit locomotive with two guiding axles and four driving axles on each unit.

This system indicates the following:

1. Number and location of driving axles and driving trucks.

2. Number and location of idle axles and guiding or carrying trucks.

3. Whether driving, guiding or carrying trucks are of the swivel or articulated type.

4. Number of idle and guiding axles in the same rigid wheel base.

5. Motive power units per locomotive.

Both the Whyte system and the Standard system of classification are given in Table I. It is clearly evident that as electric locomotives increase in size and length that the use of the Standard system becomes more advantageous.

The use of the system employing numerals, only, is almost prohibitive when idle and driving or guiding and driving axles are included in the same wheelbase, as in items 19 and 25. The AC + CA type, item 25, employs a driving axle as a guiding axle, with all four axles in the same truck, but not in the same rigid wheelbase. A clear classification is impossible with the Whyte system.

No attempt has been made to indicate the number of cabs on any one motive power unit as this would complicate the system. Likewise the method of drive, whether side rod or individual motor drive, has been omitted for the sake of simplicity. The most simple system will find the most general use in the railroad field.

The table includes only electric locomotives which have been constructed or are in course of construction. Many other possible arrangements of wheels and trucks could be given if desired. Inspection of the table reveals that practically all of the electric locomotives are designed for operation from either end whereas the steam locomotives are designed for normal operation in only one direction.

The new system here described is equally well adapted to the classification of steam locomotive wheel arrangements. A system of classification which satisfied both classes of equipment might well be called the "Standard system" of locomotive classification.

The classifications of wheel arrangements have not heretofore indicated the application of a booster or auxiliary locomotive to trailing axles and tender trucks. These outfits operate only part time in supplying tractive effort and therefore should not carry the same designation as for idle axles and main driving axles. The Whyte system would require modification to care for this feature whereas the standard system here described will provide for this designation by using minor letters to represent boosters on steam locomotives. Thus for a Pacific type locomotive having a booster on the trailing axle the designation would be 2-C-a. When two axles on the tender are equipped with a booster the standard system of wheel classification is easily applied, using the letter C to represent them.

TABLE I

ELECTRIC LOCOMOTIVE CLASSIFICATION

NO. WHEEL ARRANGEMENT	SYMBOL WHYTE SYSTEM	SYMBOL STANDARD SYSTEM
1—OO	0— 4—0	B
2—OOO	0— 6—0	C
3—OOOO	0— 8—0	D
4—OOOOO	0—10—0	E
5—oOOo	2— 4—2	1—B—1
6—oOOO	2— 6—0	1—C
7—oOOOo	2— 6—2	1—C—1
8—oOOOOo	2— 8—2	1—D—1
9—oOOOOOo	2—10—2	1—E—1
10—ooOOo	4— 4—2	2—B—1
11—ooOOOo	4— 6—2	2—C—1
12—ooOOOOo	4— 8—2	2—D—1
13—ooOOoo	4— 4—4	2—B—2
14—ooOOOoo	4— 6—4	2—C—2
15—ooOOOOoo	4— 8—4	2—D—2
16—OO—OO	0—4— 4—0	B—B
17—OOO—OOO	0—6— 6—0	C—C
18—OO+OO	0—4+ 4—0	B+B
19—OO+oO	impossible—	B+1A
20—oOO+OOo	2—4+ 4—2	1—B+B—1
21—oOOo+OOo	2—4— 2+0—4—2	1—B—1+B—1
22—OOO+OOO	0—6+ 6—0	C+C
23—oOOO+OOOo	2—6+ 6—2	1—C+C—1
24—oOOOo+oOOOo	2—6— 2+2—6—2	1—C—1+1—C—1
25—OOOO+OOOO	impossible—	AC+CA
26—ooOO+OOo	4—4+ 4—2	2—B+B—1
27—ooOO+OOoo	4—4+ 4—4	2—B+B—2
28—ooOOOo+oOOOoo	4—6— 2+2—6—4	2—C—1+1—C—2
29—OO+OO+OO	0—4+ 4+4—0	B+B+B
30—OO—OO+OO—OO	0—4— 4+4—4—0	B—B+B—B
31—ooOO+OO+OO+OOoo	4—4+ 4+4+4—4	2—B+B+B+B—2
32—oOO+OOOO+OOOO+OOo	2—4+ 8+8+4—2	1—B+D+D+B—1
33—oOO+OOo+oOO+OOo	2—4+ 4—2+2—4+4—2	2(1—B+B—1)
34—oOOOOo+oOOOOo	2—8—2+2—8—2	2(1—D—1)
35—oOOOOo+oOOOOo+oOOOOo	2—8— 2+2—8—2+2—8—2	3(1—D—1)

Armature Testing Stand for the Repair Shop

A Detailed Description of the Design and Operation of a Device for Testing Direct Current Armatures

By Niels Hansen
Assistant Foreman Electrician Southern Pacific Ry., Oakland, Cal.

AN armature testing stand for use in the electrical repair shop is shown in the illustration. The operator is holding the millivoltmeter leads on the commutator of a U. S. L. type M armature for a bar to bar drop test. Due to an oversight in taking the picture, the brushes are shown in approximately a 90 degree position. The cables which supply the current from the test board to the brushes through the terminals A-A¹ are not connected up.

This device, designed by the writer, has been in constant service over five years and has proved itself to be a valuable piece of apparatus. As its name implies, it is a device designed especially for the testing of train lighting and headlight armatures varying in size from the small Pyle types K, E2 and C headlight armatures to the large 100 ampere, U. S. L. and Safety 4 kw. armatures. Any of the various defects that armatures fall heir to, such as shorts, opens, grounds or wrong connections, can be quickly located and the necessary repairs made. It only takes 2 or 3 minutes after placing an armature in the stand to make the necessary connections to the test board and start testing. The test board was described in the February, 1926, issue of the *Railway Electrical Engineer*. All meters, rheostats, cables, etc., are convenient and only need to be plugged into circuit. There is no time lost fooling around with portable meters and rheostats or hunting for pieces of wire to make connections with.

There are several interesting features embodied in the design of this device both mechanical and electrical:—

1. It is portable and equipped with double castors so it can be moved or turned around in any position in order to get the light from the window on the part of the armature desired.
2. The supports for the armature consist of a pair of rollers at each end of the stand which can be seen in the illustration. The left hand pair are mounted on an iron support which can be moved in or out as desired to accommodate various lengths of armatures. This is also adjustable vertically so as to level an armature having a shaft with a different diameter on each end. These rollers enable the heaviest armatures to be turned with but very little effort while testing.
3. The stand is well braced and rigid and is protected on top with a covering of 16 gauge galvanized iron. Iron rods with nuts on each end pass through the wide boards to prevent splitting and warping.
4. The millivoltmeter is permanently mounted on a bracket in a convenient place as near the commutator of the armature under test as possible and inclined so it can be easily read.
5. A small carbon pile rheostat is permanently connected up in series with the meter so that the readings can be adjusted to any value desired for comparative bar to bar tests.
6. The brush holders can be quickly adjusted to any position from 180 deg. apart on the small headlight armatures to a position where the brushes are 90 deg. apart on the commutators of the large 4 K.W. armatures.
7. A third terminal B is provided on the right hand end of the stand between the two main terminals A-A which is connected to ground through the rollers and the shaft. By simply switching a cable from one of the terminals A-A¹ to this terminal a current of any desired value can be sent through the ground of a grounded armature in order to make the defect manifest itself by the sputtering of an arc or by heating up and smoking.

How the Stand Is Built

The stand measures 40¾ in. high from the floor to the center of the stationary rollers on the right hand side or about 42 in. to the center of the shaft of a U. S. L. armature when resting on the rollers. It is 27 in. long and 24 in. wide at the bottom, the top being 12 in. wide. The two main side upright pieces are 2½ in. x 6 in., the bottom pieces 2½ in. x 3 in., the braces 1¾ in. x 2½ in. and the top and right hand end 1¾ in. x 12 in. Oregon pine. The top of the stand or table is 32¼ in. above the floor.

The rollers for supporting the armatures are made of machine steel. They are crowned 1/16 in., measuring 2¾ in. diameter in the center, 1¼ in. thick with a bore of ⅞ in. So that the head of the roller shaft will not project beyond the inside surface of the rollers the latter are counterbored 5/16 in. deep by 1¼ in. diameter. The ⅞ in. diameter shaft bolts are turned down to ⅝ in. and threaded leaving a square shoulder which when drawn up against the roller, supported with ⅝ in. nuts, allow the rollers to just turn freely. The two pair of rollers are each spaced 2¾ in. centers.

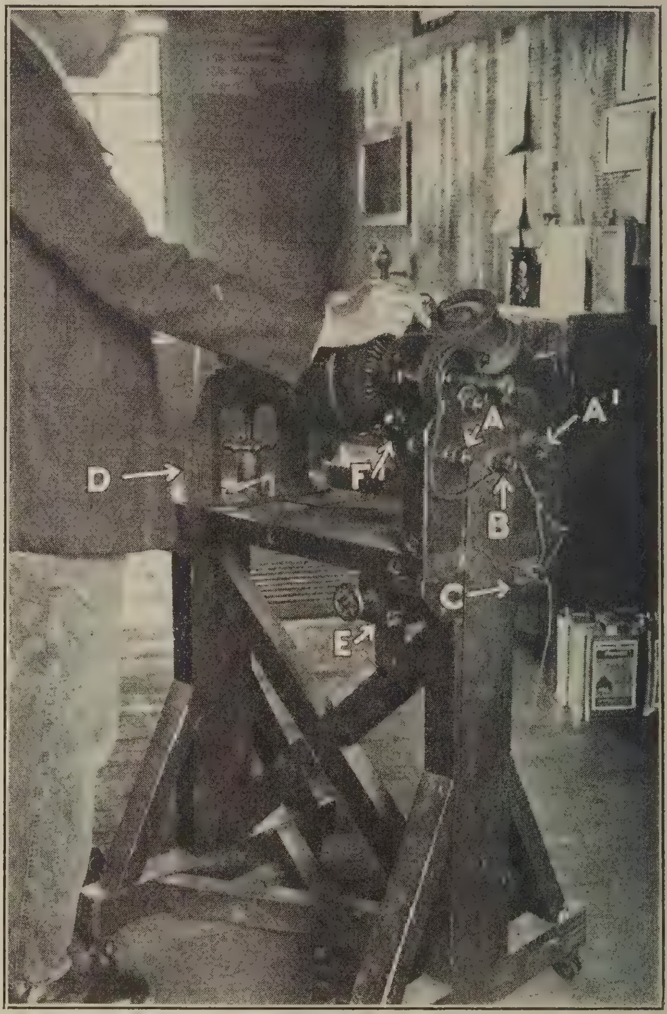
The movable or left hand roller support D is made from 3/16 in. tank steel bent at right angles. A section of the vertical part is cut out and the vertical edges thus formed are made into two grooves by riveting pieces of ⅛ in. by 1 in. band iron on each side so they project about ¼ in. to form the grooves. Another piece of 3/16 in. tank steel 3 in. by 6 in. upon which the pair of rollers are directly mounted slides up and down to these grooves. Riveted to this slide at the bottom in the center is a ¾ in. rod threaded the full length and passing through the threaded valve handle, the latter being used to raise or lower the slide. The rod is of sufficient length to permit the center of the rollers to be raised from 1¾ in. below to 1 in. above the centers of the right hand rollers. Support D can be moved from a position where the minimum distance between the rollers is 13 in. to a position where the maximum distance is 21 in. A piece of ½-in. square iron 5 in. long is screwed to the bottom side of D and engages in the slot shown in the top of the stand. An inverted ½-in bolt passes through this

slot and through the support D. The head of the bolt slides in a square groove formed by pieces of light iron screwed to the under side of the top of the stand, along side of the slot. As may be recognized in the picture a U. S. L. No. 10044 terminal bolt wrench is screwed on the projecting end of the bolt and provides a ready means of quickly securing the support D in the position desired.

The millivoltmeter is a 5-in. diameter Weston D. C. ammeter having a 125-0-125 ampere scale. It is used without a shunt and calibrated to read directly in millivolts. The bracket upon which it is mounted stands at an angle of 45 deg., so that the meter can be easily read. It makes no difference which way the meter leads are held against the commutator bars because the meter will indicate the drop on one side of the scale or the other. A No. 549—Western Electric Company, 2 ft. 6 in.—2 conductor telephone cord is used for the meter leads. The two small round plug contacts of the cord are incased in a fibre block 9/16 in. wide x 2 in. long x 5/16 in. thick. These two contacts are spaced ¼ in. centers and their ends project ¼ in. from the fibre block. The other two ends of the cord are fastened to the two small binding posts shown at C. The positive meter terminal is connected to the right hand post and one side of the small carbon pile E is connected to the left hand binding post. The other side of the carbon pile is connected up to the negative meter terminal thus connecting the carbon pile in series with the meter and meter leads.

The carbon pile rheostat E is mounted just under the table part of the stand on the right hand side. The supporting frame for the carbons is made from a piece of ⅛ in. x 2½ in. band iron bent U shaped 6½ in. long by 3 in. high. Four 3/16 in. iron rods, each passing through a No. 10290 U. S. L. lava tube are screwed into one end of the frame and pass through clearance holes in the other end. These tubes form the insulated guide supports for the carbons which consist of 5 inches of alternate 1/32-in. and 1/16-in. x 2⅛-in. diameter, carbon discs, U. S. L. catalogue No. 10266 and 10267 respectively. The thrust plates are made from 3/16 in. carbons and 1/32 in. brass terminal plates for the leads to fasten to. Pressure on the carbons is regulated by turning the valve handle which can be seen in the picture. The object of the rheostat is to regulate the range of the voltage drops so they will register about 75 to 100 millivolts on the meter scale.

The brush holders, as previously stated, are adjustable to any position on any diameter commutator encountered in train lighting work. The two main terminals A-A^1 are spaced 7½ in. apart. The inside end of each terminal is turned down to a diameter of ½ in. x 1 in. long and fits into one of two holes in each of two ⅞ in. x ⅞ in. x 3¼ in. brass links which connect each terminal to its brush holder arm. Either brush holder arm can therefore be revolved to any position in a 2½-in. diameter circle. Both ends of each link are split and equipped with ⅜-in. thumb screws to secure the parts in the position desired. The end of one link and its thumb screw can be seen at F in the picture as well as one of the brush holders. The end of the horizontal brush holder arm is also split so that the thumb screw at the end of it will clamp the brush holder rod which passes through it in any position. The movement is about 2½ in. The brush holder is made up of five parts: the brush, brush jacket, swivel pin and wing nut, tension spring and the lower rod for adjusting the height of the brush. The brush is a brass capped carbon brush 1⅝ in. long by 1¾ in. wide by ½ in. thick formerly used on the old Bliss Buckers. It is made swivel by means of a 2 in.-14-20 rd. hd. brass machine screw passing through a ¼ in. hole drilled through the full width of the brush ⅝ in. from the brass capped end. A U shaped bronze bracket ¾ in. wide fits closely over the ends of the brush with the 14-20 screw passing through the ends of this bracket, a small wing nut on the end of the bolt locks the brush in a position where it fits squarely on the commutator. Riveted and sweated to the back of the brush bracket is a piece of .035 phosphor bronze flat spring ⅝ in. wide by



Testing Stand As Used for Bar to Bar Test

3 in. long reinforced by a shorter piece at the bottom where most of the strain comes. The other end of the main spring and the short spring are riveted and sweated into a slot cut in a ⅝-in. diameter head of a ⅜-in. round brass rod 4 in. long. The tension on the brushes is adjusted by turning the horizontal brush holder arm and locking it. Both brush holders are alike.

Testing Armatures

The ground terminal B is similar to the main terminals A-A^1. Besides being used to send a heavy current through a ground of a grounded armature it is also used in conjunction with the millivoltmeter to quickly and accurately locate a grounded coil. This is accomplished by having the meter register the drop between ground and any bar

with sufficient resistance in circuit to come within the range of the scale. A light current of say 5 to 10 amperes is flowing from brush to brush through the armature while making this test. The positive meter terminal at C has a small wire hanging loose; this is used to touch the commutator bars with while the negative terminal of the meter in series with the carbon pile is connected by a small wire to the ground terminal B. As the lead on the commutator is moved from bar to bar by turning the commutator a bar will be reached where the deflection is zero. This is then the bar to which the grounded coil is connected or else it is the bar which is grounded as the case may be. The connection between B and C is ordinarily left disconnected at C. A small one-ampere enclosed meter fuse protects the millivoltmeter from accidental overvoltage.

All repaired or rewound 40 or 80 volt armatures (80-volt machines have practically been done away with by the Southern Pacific) are tested with 440 volts a.c. to ground and then put through a bar to bar drop test on the armature testing stand before and after turning the commutator and under-cutting the mica. The brushes on the test stand are set in approximately the same position on the commutator as the brushes are on the generator. The current which is 32-volt battery current is adjusted so that about 10 to 15 amperes flow through the headlight armatures, about 35 to 45 amperes through the wire-wound axle generator armatures and about 60 to 75 amperes through the strap copper wound armatures. After the current is properly adjusted, the test leads or rather millivoltmeter leads are then placed on two adjacent bars as shown in the illustration and the deflection noted and adjusted to about 75 to 100 millivolts by manipulating the pressure on the carbon pile E. The higher the reading the less liability there is to overlook small variations in drop. If the armature is O. K., all bars should register the same drop between adjacent bars. A dead short between two bars will register no deflection when the leads are touching on these bars. A poorly soldered or blackened lead will show up by a slightly higher reading than the other bars while a partial short such as a speck of solder or copper bridging two bars will show a few points lower deflection. A wide open, such as a broken lead, will throw the needle off the scale because the meter then brings the open.

A condition sometimes arises where the front knuckle of a coil becomes shorted to the bottom lead of some other coil usually on a U. S. L. Type M. or O. armature which was not properly insulated when wound, allowing these parts to chafe the insulation on the wires; a similar condition in hand wound armatures such as the consolidated Type A exists when different coils become shorted where they cross one another, generally due to a blow or knock of some kind. While the bar to bar test does not locate the exact coils, this condition is indicated by quite a number of bars showing a varying deflection when the test leads of the millivoltmeter are held on two adjacent bars and the armature turned slowly. When a case of this kind is found the armature is placed on a winding stand, all the top leads are raised and each lead tested with every other lead with a buzzer test set on the test leads from the 110 volt A. C. lamp bank on the shop test board. In making this latter test the top leads which have just been raised are shorted with a piece of about No. 20 bare copper wire wrapped a couple of times around the end of each lead in rotation. Thus, one lead at a time is removed from this short circuiting wire and tested for a circuit with the other leads still shorted. The leads showing a circuit are bent back and marked until all the rest have been tested. These defective coils are then repaired and the armature tested again.

Occasionally a coil in a parallel wound armature may have its leads connected up reversed. This would be indicated by a reversed deflection of the same value as the other coils.

The Chicago Union Station Which Was Placed in Service Last Year

Maintaining an Electrical Contact System

Swiss Federal Railroads Have Well Developed Organization for the Maintenance of Overhead Catenary

By H. W. Schuler

Electrical Engineer, Swiss Federal Railroads

THE electrification of a steam railroad calls for the creation of a new staff of employees, which cannot be recruited from those already employed for maintenance work on the steam operated railroad. The maintenance of the contact line must be done by linemen expert in the construction of catenary lines and, as in the case of the Swiss Federal Railroads with its 15,000-volt contact lines, they must be men accustomed to high tension work. They must be ready at any time to repair damage on the contact line in as short a time as possible. As a rule, the whole section between two substations feeding simultaneously into it is influenced by a disturbance occurring on the lines, as in most cases this disturbance is a short circuit. Then traffic is suspended until the short circuit is located and that part of the lines cut out which contains the fault. It is not the purpose of this article to go into the details of the sectionalizing systems which help to eliminate faults quickly, but it may be stated that in most cases it is possible to cut out a defective part of the contact lines in so short a time that traffic is not delayed. It may happen, however, that even though a section is fed from both ends, through traffic cannot be maintained. Then quick repair work is the first and most important thing to be done.

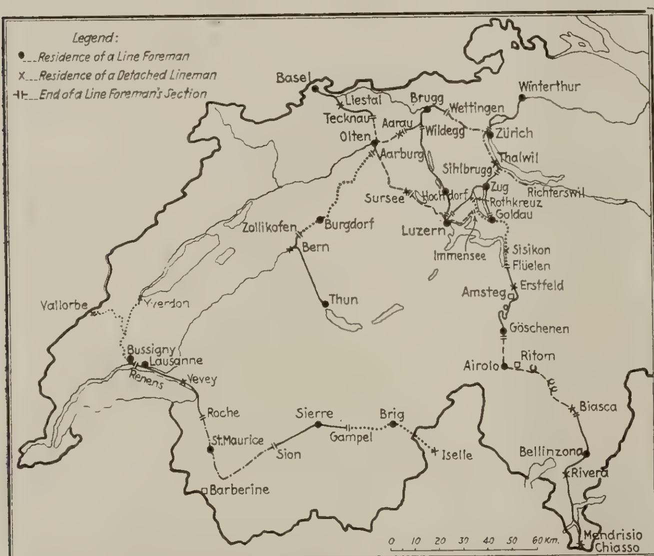


Fig. 1—Map Showing the Line Foremen's Sections of Those Lines Electrically Operated at the End of 1925

In order that it may take but a short time to get skilled repairmen to the place where a disturbance has occurred, linemen in charge of the maintenance of the contact lines are distributed along the electrified lines. They are stationed at places where the probability of disturbances occurring is greatest and where they are able to reach places further away in a short time. Fig. 1 shows the distribution along all of the Swiss Federal lines which will be electrically operated at the end of 1925. The organization within the three divisions of the railroad system and between divisions and general administration is shown in Fig. 2.

A line maintenance crew consists of from four to eight linemen and a foreman according to the importance of the section which they have to maintain. Sections which comprise stations and lines with steam and electric traction mixed require a larger crew than with electric traction only and with climatically favorable conditions. In large stations and terminals, where there is still intensive steam operation, insulator cleaning can only be done by the aid of men employed especially for that purpose. The reason for this is that the intervals between trains are so short that certain parts of the overhead lines can be disconnected only for a few hours a day. As a rule, line foremen are attached to such stations from which different routes branch off. In most cases these are stations with an important switching service, so that there are always steam locomotives at hand for any emergency. In case of more important disturbances, when a special repair car has to be used, such steam locomotives are of great value.

If the section of a line foreman is quite long, or if it comprises a large station which is not the residence place of this foreman, some of his men will be detached. In case of a disturbance in the neighborhood of their station or residence they will be able to start repair work long before the foreman reaches the place of trouble. For normal repair work these men are called in with the rest of the gang. The detaching of linemen is especially important on routes with heavy traffic and single track only.

As a matter of course a section belongs to a line foreman only as far as normal repairs and regular maintenance work are concerned. As soon as a disturbance occurs, which as a rule shows up as a short circuit, it is the duty of every foreman and of all linemen who happen to be in the neighborhood to do whatever they can for quickly locating and eliminating the disturbance wherever the boundary of a section may lie.

Line foremen through whose sections transmission lines pass, have to control and maintain these lines also. Where such lines do not follow the railroad and cannot be watched from it, individuals are engaged to patrol certain parts of the transmission line and to report immediately in case irregularities, such as broken insulators, abnormal sag and so forth, are observed.

A certain number of line foremen are put under the supervision of a line engineer who has his residence in a railroad center. His principal function is to see that his line foremen do their work systematically, that control work is done in due time, that—and this is most important—in case of extensive disturbances repair work is well organized. Beside that he has to manage all of the ad-

ministrative work that is a part of any large enterprise.

The line engineers report to the division electrical engineer. The functions of this engineer consist of supervising the maintenance of the transmission and contact lines and of the substations, of consulting and planning as far as line construction work is concerned, of purchasing the materials necessary for maintenance work and of working up of the disturbance reports.

The division electrical engineers report to the contact line office, which is a section of the electrification department attached to the general administration office. This office collects and compiles the data concerning the different parts of the overhead constructions and makes them known to the other divisions. Here also standard forms of catenary construction are worked out and the progress of all work is watched to see that it conforms with the requirements of federal law. Experiences on one division are made known to the electrical engineers of other divisions by letter, if matters of minor importance are concerned. If the experiences are of a considerable importance and special clarification is wanted, they are discussed in a conference, at which all those participate who are experts in such matters.

The line maintenance service is attached to the service of the chief engineer of way. This is not usual as in most instances it is attached to the service of traction, but it is not important, as a combination with anyone of these services is of no particular value. The purpose of such an arrangement is to reduce the number of men employed but it does not accomplish this purpose. What might be possible is the putting together of similar functions, such as line foreman and substation foreman, of substation operators and linemen, and such combinations are now being tried.

The section of a line foreman comprises an average of 31 miles of electrified route, including 77 miles of track equipped with overhead lines. The section that belongs to a line engineer comprises an average of 98 miles of electrified route including 232 miles of track equipped with overhead lines. As an average, per lineman, there are 5.2 miles of electrified route including 12.7 miles of track equipped with overhead lines. As an average, per employee who is occupied with contact line maintenance, there are 4.2 miles of electrified route including 10.2 miles of track equipped with overhead lines.

Extensive disturbances which need many hours for

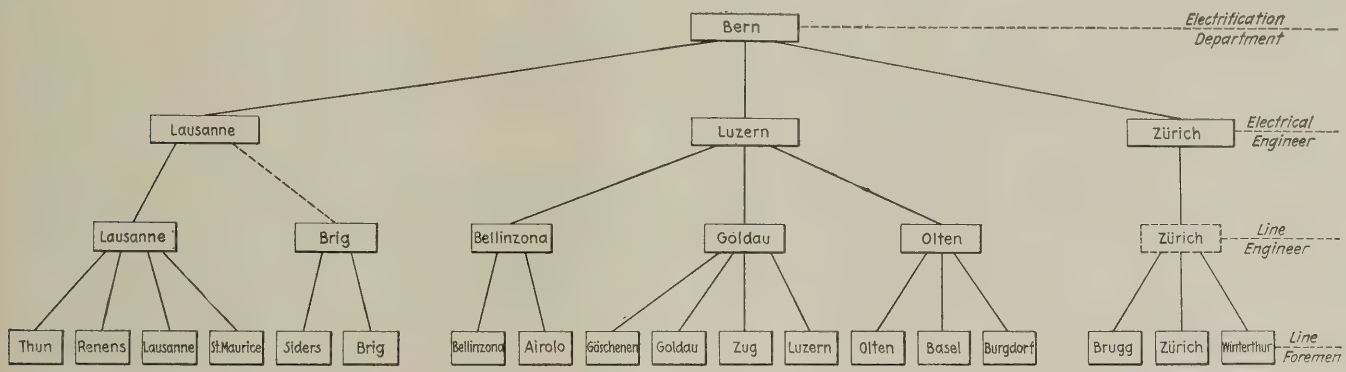


Fig. 2—Organization of the Line Maintenance Forces

Fig. 3—Inspection Motor Car

Fig. 4—Rolling Ladder for Repair Work

repair where the time needed to get to the place of disturbance is of no great importance, are unusual. The usual disturbance is one that can be repaired by using ladders. This means that it is most important to be able to bring the maintenance crew as quickly as possible to the place where repair work has to be done. For this reason every line foreman has an inspection motor car. Fig. 3 shows such a car which will carry four persons and a

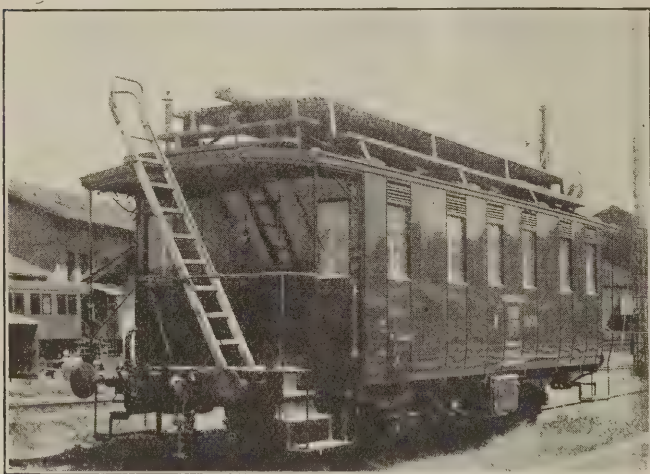


Fig. 5—Repair Car

ladder on a 1 per cent grade at a speed of about 25 miles an hour. The rating of the motor is from 6 to 8 h.p., the weight of the car about 770 pounds, and the price about $840. Emergency material and tools, such as insulators, hangers, clamps, stranded wires, come-alongs, pulleys, keys, wrenches, pliers, portable telephones and grounding sticks can be loaded on the floor of the car. A rolling ladder, shown in Fig. 4, has been found particularly useful. It consists of a little car with a trestle on it, on which

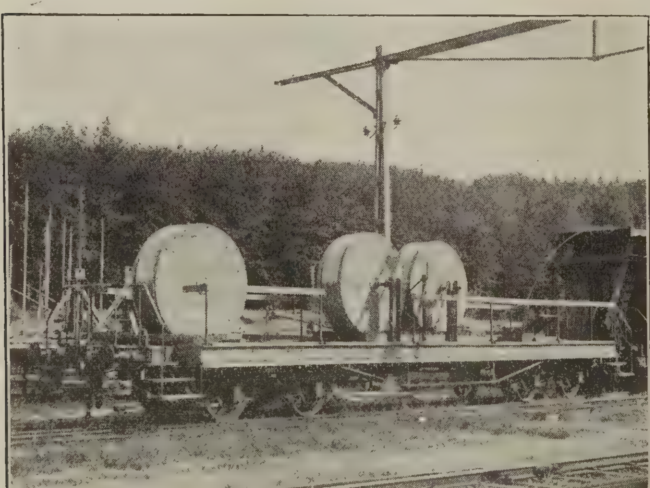


Fig. 6—Emergency Car

a sliding ladder is mounted. From four to six such rolling ladders are distributed over the section of a line foreman. They are painted red and white like a carrier or a signal pole so as to be easily visible at a distance.

Special repair cars, such as shown in Fig. 5, are used for more extensive repair work and for finishing up emergency repairs. There is one of these on each line foreman's section. A platform is mounted on the roof which can be turned at 90 degrees to form a side platform. The interior of the car is divided into two parts, one a workroom with a work bench, a vise and a set of tools; the other part a storeroom with all material necessary for more extensive repairs. Both rooms are equipped with electric light and the workroom is equipped with a stove for heating. The car is so built that it can run in express trains. As a rule old passenger coaches are used for such repair cars.

Heavy parts, such as poles, oil circuit breakers and so forth, are transported on push cars equipped with brakes and used as trailers. These cars may be loaded up to about 1,700 pounds.

Line foremen who have transmission lines to patrol and maintain which do not follow the route but which can be reached by street have a motorcycle or a small automobile. Cars like the one shown in Fig. 6 are used for heavy

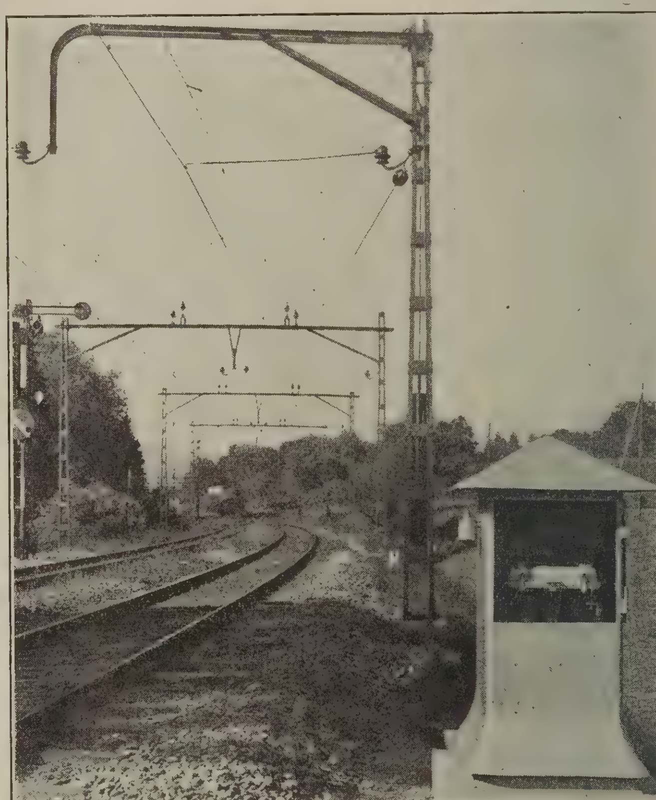


Fig. 7—An Example of the Type of Overhead Construction Used Showing Cable Hut at the Right

repair work and fortunately are very seldom required. These cars are equipped with material that cannot be loaded on the repair cars, such as messenger strand and contact wire in lengths sufficient for repairing up to 1,500 feet of damaged contact line, wooden poles and timber to support damaged line structures or to temporarily replace destroyed poles and overhead bridges. These cars are located at railroad centers where many distant points can be reached in relatively short time. Such centers always have steam locomotives at hand for hauling the cars to the place where they are needed.

Beside these cars each division has a so-called observation or inspection car with a special-built middle part not unlike the cupola of a caboose to enable unhindered observation of the contact line and of the working of the pantagraphs.

When this car is used it is put in a regular train next to the locomotive. A speedometer indicates the train speed.

Roof mounted lights permit observation of the contact line in tunnels. A wire mesh in front of the observation windows protects the observers. The regular inspection of the line by means of this car is important. Even a small shifting of the contact wire may cause a derailment of the pantagraph shoe which is only 3 feet wide because of the small tunnel clearance. Grounding stick and portable telephone are important tools of the lineman. With the grounding stick he protects himself against induced voltages, but mainly against wrong switching. Naturally the ground stick leads have to be of sufficient size to stand the heaviest currents to be expected without being damaged in any way.

The portable telephone is important for communication between working place and station or powerhouse where switches have to be operated which cut out the section of contact line to be worked on. The portable telephone can be connected to the telephone line at the cable huts, Fig. 7. These are about half a mile apart and contain the cable splice boxes. Line foreman and linemen wear the same uniforms as all the other railroadmen with the exception of a short rain-proof coat instead of an overcoat as their work requires a measure of acrobatic skill and has to be done regardless of weather conditions. A special hat replaces the regular cap which is of no use in bad, rainy weather.

The costs of maintaining the contact line amounted to $170,000 in 1924, which means $450 per electrified mile of route and $185 per mile of track equipped with contact line. Of these amounts about 75 per cent is expended for wages, clothes, etc., of the men engaged in line maintenance. The sum of $170,000 represents 1.28 per cent of the total capital invested in contact lines at the end of 1924.

Silesian Electric Freight Locomotive

A new design of electric freight locomotive has been developed by the A. E. G. Company in Europe to meet the present demands of traffic on the Silesian mountain railways.

The locomotive is driven by four motors arranged permanently in two groups in series so as to form two double motors. These motors are fed from a transformer

Silesian Electric Freight Locomotive

so that the greatest difference of voltage across the terminals of the double motor is 840 volts, while the maximum pressure to earth does not exceed 420 volts. Control is effected by electrically operated compressed air contactors, which are fixed on the transformer so that a short and simple wiring system made up of flat copper bars is obtained.

The locomotive has two three-axle trucks. Each truck carries one of the double motors, the underframe of which is used to support both the bearings for the gear spindle and the armature shaft. The three driving axles, which are coupled together by rods, are driven by the double motor gear shaft, the centre of which is 10 in. above the centre of the driving axle, through slightly inclined connecting rods so that the diagonal rod engages with the coupling rod on the driving axle near the middle of the locomotive.

The transformer is placed at the centre of the locomotive on a bridge whose two ends rest on the underframe.

Principal Characteristics

Gauge	4 ft. 8½ in.
Driving wheels, diameter	4 ft. 1 in.
Length over buffers	55 ft.
Fixed wheel base	14 ft. 9 in.
Total weight	264,000 lb.
Axle load	4,400 lb.
Trolley voltage	15,000
Frequency (cycles)	16⅔
Maximum tractive effort	59,500 lb.
Maximum speed	34 m.p.h.
One hour rating at 19 miles per hour	2,300 hp.
Gear ratio	1:4.04

The bearing points also serve for coupling the two parts of the locomotive frame together.

The locomotive housing is in three portions, the two outer parts being rigidly connected with the underframe. They enclose the double motor, as well as the cooling equipment. A driving compartment at each end of the locomotive contains the control equipment. The middle portion of the housing is supported by the transformer bridge and encloses the transformers and the contactors. The three portions of the housing are connected together by flexible gangways.

Ewing Galloway

Beginning of New York Central Improvements, Involving New Yards and Electrification, on West Side, Manhattan, New York City, Freight Line

THE INTERCHANGE

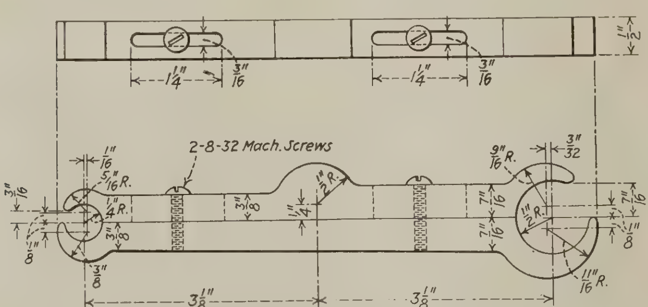
Fuse Puller

By J. H. Wickman
Mechanical Engineer, The Newport Company, Milwaukee, Wis.

There have been several articles written during the past year in different electrical magazines in regard to the merits of different kinds of cartridge fuse pullers. It is only fair to say that they do not all possess the same degree of merit.

The one shown here is made of hard fiber and has proved itself worthy of its name. The one feature incorporated in this design is that it does not work like a pair of tongs as do many other devices used for pulling fuses.

By leaving either end with one side shorter than the other, one-half of the puller slides over the other half, thereby allowing a very thin end available to get in between two cartridges fuses. The shorter side is again moved back to the position shown in the sketch and in this position the fuse is grasped by the puller and pulled.



Construction Details of Unique Fuse Puller

The designing of a tool or machine that will accomplish its purpose at all times with a minimum amount of maintenance or trouble to the person using it, is not to be compared to a tool or machine that is just thrown together and will accomplish just a part of the work it is supposed to do and only that a part of the time.

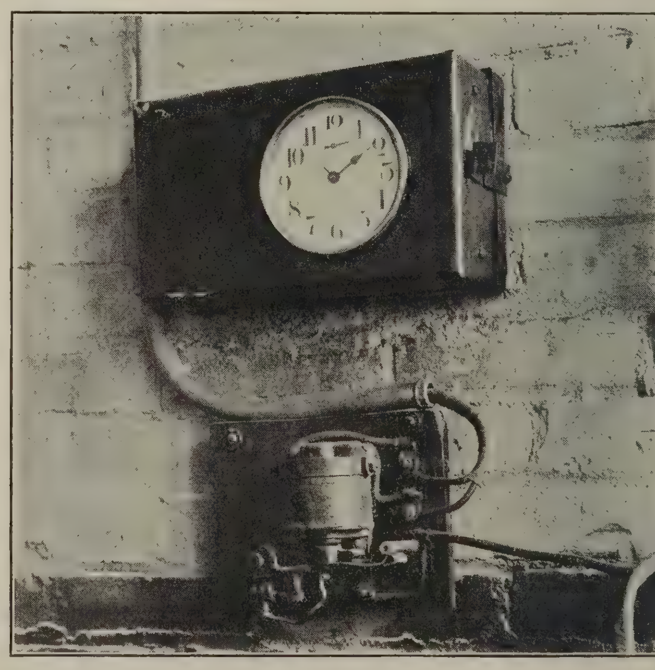
When we see merit in some idea presented by a man, it is our policy to incorporate the ideas of several men before adopting it and allowing it to be made at a considerable expense and then finding out afterward that it might have been improved upon.

This fuse puller was the idea of an electrician who is a lineman. It was not his idea to use it in its present form, as the shorter piece, the out of center ends and the large and small ends were final improvements added to his original idea.

I have made these last remarks in order to convey to the younger men on the railroads, who are continually presenting new ideas and kinks, the thought of always giving their ideas more consideration before presenting them. Oftentimes someone else can improve upon an idea to such an extent that the original idea is of very little value or importance.

Starter for Soldering Iron Furnace

A small electric furnace is used for heating soldering irons in the electricians' shop on the Chicago, Milwaukee & St. Paul at Deer Lodge, Mont. The furnace is convenient and clean and requires no watching, but about one hour is required to get it hot enough for heating irons after the current is turned on. Usually the furnace is needed as soon as the men start work in the morning and the device shown in the illustration was made to turn the current on the furnace one hour before the men arrive.



A Control Contact in the Clock Operates the Relay Which in Turn Closes the Furnace Circuit

The cabinet contains an alarm clock and a contactor. The contactor is simply a lever pivoted near the center with a contact point and pigtail connection at one end. The other end of the lever lies across the winding key

of the alarm clock. When the alarm sounds, the key turns and causes the contact on the other end of the lever to engage with a fixed contact. This energizes the relay shown below the cabinet which in turn closes the electric furnace circuit.

When the work is finished for the day the furnace is turned off and the clock is set so that the circuit will be closed again one hour before the whistle on the following morning.

Effort

Man owes his growth, his energy, chiefly to that striving of the will that conflicts with difficulty, which we call effort. Easy, pleasant work does not make robust minds, does not give men a consciousness of their powers, does not train them to endurance, to perseverance, to steady force of will, that force without which all other acquisitions avail nothing.

Better Proof Demanded

One day an Irishman was seated in the waiting room of a station with an odorous pipe in his mouth. One of the attendants called his attention to the sign "No Smoking."

"Well," said Pat, "I'm not smokin'."

"But you have a pipe in your mouth."

"Sure, an' I've got shoes on me feet, an' Oi'm not walkin', either."—Dartmouth Jack-o'-Lantern.

Timetable Needed

"What time does the evening train arrive?" asked the motorist. "I've been waiting for it an hour."

"In five minutes," replied the station agent. "Want a ticket?"

"No; I want to race the blamed thing to the crossing."
—*American Legion Weekly.*

Time to Move

Workmen were making repairs on the wires in a Norwood school house one Saturday, when a small boy wandered in.

"What you doin'?"

"Installing an electric switch," one of the workmen said.

The boy then volunteered: "I don't care. We've moved away, and I don't go to this school any more."

To avoid that run-down feeling, Cross Crossings Cautiously.

Trainmaster—"How much experience have you?"

Boomer—"Give me another application blank."

Trainmaster—"Oh, just name a road you made a round trip on."—*D. T. & I. News.*

Lady Passenger: I have no use for that Conductor. He yawned three times while I was talking.

Brakeman: He probably wasn't yawning. He was only trying to say something.—*A. C. L. News.*

It is well for a man to respect his own vocation whatever it is, and to think himself bound to uphold it, and to claim for it the respect it deserves.—*Charles Dickens.*

Your Job

How do you like the job you're at
  Throughout your working day?
When the whistle blows and you're ready to quit,
  Do you think you've earned your pay?
Do you think you have given the best you've got
  To this job that is yours to do?
If you had to sit down and balance accounts,
  What credit is comin' to you?
Are you puttin' your shoulder behind the wheel
  And pushin' with all your heart;
Or are you just layin' down on the job,
  Lettin' someone else do your part?
Do you think of the fellow beside you,
  The one who'll contest your crown?
He may look to you for example;
  Are you helpin' him up or down?
Are you thinkin' in terms of tomorrow,
  In this job that is yours to do?
Do you know that the world is dependin'
  On just such chaps as you?
There's only one way you can answer,
  Keep pluggin'—your pulses will throb
When you find you're on top of the ladder—
  Through stickin' right close to your job.

Modern Fables

Little Jack Horner
Sat in the corner
  Of the street car, when there was a jam.
He rose to his feet,
Gave a lady his seat—
(I'm a liar. I know it. I am.)

A Natural Mistake

Section Foreman—They tell me you had a fight with your wife.

Section Hand—Yes, and it was some bout, believe me.

Section Foreman—Liquor, I suppose?

Section Hand—No, she licked me.

Do you want to know if you are destined to be a success or failure in life? You can easily find out. The test is simple and infallible. Can you save money? If not, drop out, you will fail. You may think not, but you will fail sure as fate. The seeds of success are not in you.—*J. J. Hill.*

The girl about to travel alone was warned not to talk to strange men.

At the station, the Conductor asked: "Where are you going?"

"To Detroit," she answered, so he put her on the Detroit train.

As the train pulled out she looked back and said: "Ha, ha, I fooled him that time. I'm going to Chicago."

Trainmaster's Wife (paying unexpected visit to his office)—You told me, Henry, that your stenographer was an old maid.

Trainmaster (flustered)—That's right, my dear, she's away ill today and sent her grand-daughter instead.—*Judge.*

Headlight for Motor Rail Cars

The Electric Service Supplies Company, Philadelphia, Pa., has placed on the market a new type of "Golden Glow" headlight with mirrored glass reflector which is especially designed for use on self propelled rail cars, multiple unit cars and similar passenger equipment. Being designed for installation on the roof of such equipment the body of the headlight is tapered and the feet of the headlight are made so that they will conform to the curvature of the roof.

The Case is Made of Aluminum With Bronze Fittings

This new headlight is known as type RA-128. The main body or case is made of one integral cast aluminum shell. Front and side doors also are aluminum and are gasketed. Fittings are of bronze.

Improved Portable Hand Lamp

The type LP line of safety hand lamps manufactured by the Crouse-Hinds Company, Syracuse, N. Y., has been improved by a change of the locking device used to lock the hinged half of the guard in the closed position. Formerly a spring was used for this purpose, but with this arrangement it was possible to release the guard by pulling too hard on the hook. The spring has now been replaced by a thumb nut which is turned down over a shoulder or boss on the end of the hinged part of the guard.

Except for this change the unit is the same as originally designed. The handle is made of seasoned maple, black enameled and contains the lamp socket and a strain relieve cord clamp. The socket is of the weatherproof type and is made of heat resisting molded insulating material. The guard and half shade are made of aluminum alloy. The hook is large and is swiveled so that when a half shade is used, the light can be directed as desired. A compression washer prevents a twisted lamp cord from turning the lamp from a set position. A few turns of the wing nut allows the hinged part of the guard to swing back giving free access to the lamp.

The Type LPH Safety Hand Lamp With Handle Shown in Cross Section

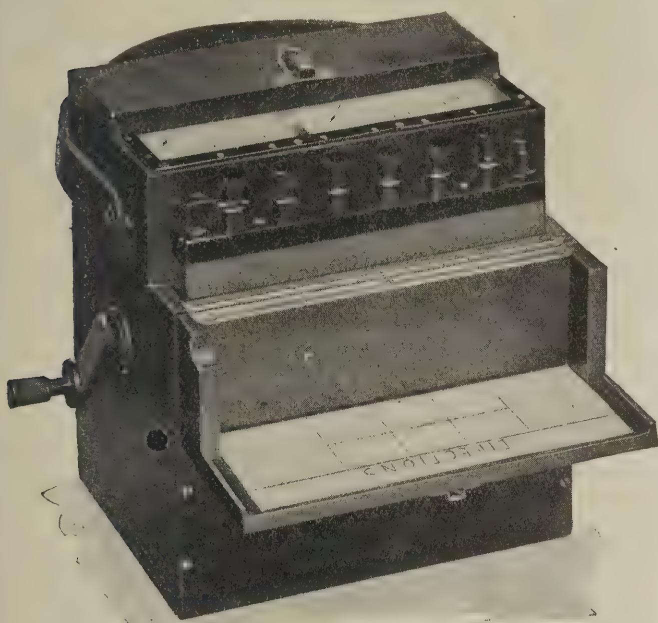
The hand lamps are made with or without a half shade and each style is made in three sizes for 25-watt G-18½ or 25 or 50-watt P-19 lamps, for 25-watt S-17 lamps or for 40-watt S-19 or 60-watt S-21 lamps.

Megohmers for Insulation Measurements

For measuring the insulation resistance of electrical machines and circuits, instruments of the hand-operated generator type are finding an increasing application. This is no doubt due to the fact that they are well adapted to this service and that the operation of any electrical system is largely dependent upon the condition of its insulation. A line of instruments for this purpose is announced by Herman H. Sticht & Company, 19 Park Row, New York. These devices are better known by their trade names as the Model "2-in-1," Model-D, and Junior megohmers.

The Model "2-in-1" megohmer represents the highest grade instrument of the group and consists of a differential ohmmeter system mounted in a cabinet with a hand-operated direct current generator. It is equipped with an a.c. and d.c. voltmeter for measuring the generator voltage and for general voltage measurements. The moving system of this instrument has no springs as in most moving coil instruments, the torque or restraining force being produced by a second coil mounted on the same axis with the series or main coil. After using, the pointer does not return to the zero position, since the torque is only produced when the potential is applied. The torque produced by the potential coil varies as the voltage of the generator while the

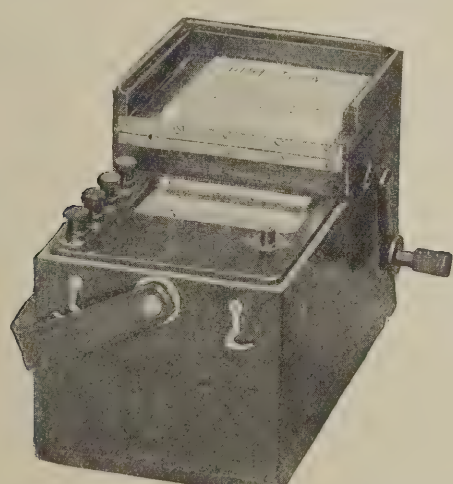
torque produced by the series coil varies with the current flowing through the resistance connected with the terminal of the megohmer. Since the coils are differentially wound, the deflection of the pointer will be directly proportional to the voltage and inversely proportional to the current or directly proportional to the resistance. Measurements are,



Model "2-in-1" Megohmer Ready For Testing

therefore, independent of voltage variations, provided the resistance itself is independent of the voltage applied.

The hand-operated magneto generator furnishes direct current of either 250, 500, or 1,000 volts. The proper testing voltage is obtained at about 180 revolutions per minute of the crank handle. A voltmeter of the soft iron type is provided principally to measure the voltage of the magneto generator. It can, however, be disconnected from



Model-D Megohmer Employs the Voltmeter Method of Measurement

the generator and megohmer system and may then be used for both a.c. and d.c. voltage measurements. The case of the "2-in-1" megohmer measures 6½ in. by 9¼ in. by 9½ in. and is equipped with a strong leather handle. Binding posts are protected by the hinged cover when closed. The net weight of the instrument is 18¼ lbs.

The Model-D megohmer is a moderately priced instrument consisting of a high grade D'Arsonval movement and a hand-operated direct current generator. This model may be used also as a direct current voltmeter. In the Model-D instrument, the voltmeter of insulation resistance measurement is used. The chief objection to this method however, is eliminated by the inclusion of a self-contained generator and a scale calibrated to read directly in megohms. The movement is of the high resistance D'Arsonval or moving coil type and is "dead beat." The inclusion of a double scale permits the use of the instrument not only as a direct reading megohmmeter but also as a voltmeter. The internal connections of the instrument are such that the megohm scale of the instrument applies not only for measurements with the generator voltage but also for measurements made with 110 and 220 volts as obtained from an outside source. The generator produces 220 or 440 volts at the terminals at 180 r.p.m. of the crank handle. The complete instrument weighs 9¾ lbs.

The Junior megohmer is smaller, lighter and lower in price than the two types just described. In several respects it is similar to the Model-D. It consists of a small but well constructed D'Arsonval system combined with a hand-operated d.c. generator. Where relative values of

The Junior Megohmer is Recommended for Telegraph, Telephone and Signal Work

insulation resistance, quickly obtainable, are more important than accurate insulation measurements, the Junior megohmer is particularly suitable. It is recommended for maintenance work where numerous circuits are tested. The measuring system of the instrument consists of a small D'Arsonval galvanometer and a double scale graduated from zero to 20 megohms and from zero to 120 volts. Full operating instructions are mounted in the cover of the instrument where they are visible to the operator when the instrument is in use. A hand-operated magneto generator furnishing 110 volts pulsating direct current serves as a source of potential for insulation resistance measurements. The rated voltage of the generator is obtained by rotating the crank at about 180 r.p.m. The crank handle of the generator is of the collapsible type and when not in use folds back under the cover of the instrument. This is a particularly convenient instrument for portable service because of its small size and light weight. The outside measurements of the instrument are 3⅝ in. x 5¼ in. x 6¾ in., and the total weight of the instrument is 4¾ lbs.

General News Section

The Northern Pacific has authorized the installation of automatic train control between Dickinson, N. D., and Glendive, Mont.; estimated cost, $95,000.

The Chicago & Alton has placed an order with the National Safety Appliance Company for automatic train control apparatus to be installed between Pontiac, Ill., and Chenoa, 10 miles.

The shovel department of Hubbard & Company, Pittsburgh, Pa., was destroyed by fire on March 1. Fortunately the fire did not in any way affect the electrical materials department, and productions and shipments on Hubbard pole line hardware and Peirce construction specialties will be continued as in the past.

The Cutler-Hammer Manufacturing Co., Milwaukee, Wis., has opened a new sales office in the Healey building, Atlanta, Ga. A. C. Gibson, formerly of the Philadelphia office, is in charge of this office. The General Machinery Co., Birmingham, Ala., will continue to serve its trade in the northern half of Alabama.

The Chesapeake & Ohio has decided to abandon the type of train control which it has had in operation for several years in favor of the intermittent inductive type. Just what system will finally be adopted has not yet been decided upon but a decision has been reached to abandon the ramp contact system which has been in use up to the present time. Over one million dollars has been spent by the road on the train control system which will be abandoned.

The new passenger terminal improvements of the St. Paul Union Depot Company, which have been under construction since 1917, are now completed, with the exception of five platforms on newly made fill, which will not be built until the fill has settled. Although construction work started in 1917, the work of planning had commenced in 1911, over one hundred schemes being prepared and discarded before the one finally decided upon was selected.

The Interstate Commerce Commission on January 30 made public orders dated January 26, by Division I (Commissioners Mayer, Esch and McManamy), approving with certain exceptions the installations of the automatic train-stop system of the Sprague Safety Control and Signal Corporation on the Creston division of the Chicago, Burlington & Quincy and the Minot division of the Great Northern, finding in each case that the requirements of its specifications and order have been met, except as noted. This device is of the intermittent magnetic induction type with forestalling feature.

The Norfolk & Western has ordered from the Union Switch & Signal Company the necessary material for the installation of the Union continuous automatic train control on its line between Roanoke, Va., and Shenandoah, Va., 132 miles, single track. There are 25 passing sidings. The order includes equipment for 50 locomotives. This is the second engine division on this road, as provided by the order of the Interstate Commerce Commission. The installation of the A. P. B. automatic signals, position-light, has been completed and the A. T. C. apparatus is to be put in as fast as possible in order to complete the work by July, 1926. This installation with the 106 miles already installed will make 238 miles continuous A. T. C. from Hagerstown, Md., to Roanoke, Va.

The Committee on Electric Rolling Stock, Division V, Mechanical, American Railway Association, headed by its chairman L. K. Sillcox, general superintendent of motive power, Chicago, Milwaukee & St. Paul, on Wednesday, February 24, went over the electrified section of the Norfolk & Western. On Thursday and Friday, the committee inspected the Virginian electrification and on Saturday, looked over the Virginian's new coal pier at Sewalls Point, Va. Among the inspection party were J. W. Sasser, superintendent of motive power of the Virginian, A. Kearney, superintendent of motive power of the Norfolk & Western and J. V. B. Duer, electrical engineer of the Pennsylvania.

Flood Lights for Night Sight-Seers

The Chicago, Milwaukee & St. Paul plans to equip the observation cars on its trans-continental trains with flood lights to enable passengers to enjoy the scenery at night. The first of these lights was used on the observation car of the Olympian Limited, which left Chicago on February 1. The lights are mounted so that they may be shifted at will.

N. Y. C. Electrifies Yonkers Branch

The New York Central on February 8 opened to electric operation the branch of its Putnam division from Sedgwick avenue station, New York City, to Getty Square station, Yonkers (7 miles). The line is largely devoted to suburban passenger traffic and multiple unit equipment is used.

The beginning of electric operation was attended by appropriate ceremonies in which railroad and municipal officers took part.

Rail Motor Cars on French Railroads

The relative economy of gasoline over coal as motive power, when traffic is light and infrequent, has induced various experiments in the use of motors on railroads in France, beginning in 1921 with a series of trials by the État Railway, according to Commercial Attaché Jones at Paris. In the first of these experiments an attempt was made to adapt the ordinary street auto-bus of Paris to use on railroads by a simple change of wheels. Later,

specially constructed cars were ordered, and trials of these began in March, 1922.

Operations extending over 25,000 kilometers proved that motor traction is suited to certain conditions of traffic. The État ordered 10 cars, substituting an 85-horsepower engine for one of 60 horsepower employed in previous trials. These motors have been in operation since the beginning of 1925, and have covered almost 120,000 kilometers with no accidents other than minor breakdowns.

The equipment weighs 15 tons in running order. There is space for two tons of baggage and two second-class compartments for passengers. The engine can draw two 10-ton cars on easy grades, and one over steep ascents. The passenger capacity of each car is 50. The normal speed of trains is 50 kilometers an hour, the engine alone being able to reach 72 kilometers.

The degree to which this equipment may prove economical, as compared with steam equipment, is not yet fully proved, since the cars have not been in operation long enough to make possible a full estimate of upkeep and deterioration. The operation of the motor trains, it is estimated, costs about 2 francs per kilometer traveled, while the similar cost for steam locomotives is 5 francs.

Report on Monmouth Junction Collision

The Interstate Commerce Commission, on February 2, issued a report, dated December 4, on the investigation made by the Bureau of Safety of the rear collision of passenger trains which occurred on the Pennsylvania Railroad near Monmouth Junction, N. J., on November 12 last, which resulted in the death of ten persons and the injury of 35.

Photographic illustrations are presented, giving two views of the cars following the collision, and one of signal No. 440 as it appears (in daylight) to a train approaching on track No. 1, that on which the collision occurred.

The assumption that Engineman Carroll, of train No. 6, must have passed signal 448 (that which indicated yellow) while he had his head inside the cab, turning on the injector, is given as that of Carroll himself. Fireman Armstrong of train No. 6 said that he saw signal 440 before Carroll did; and that Carroll then applied the air brakes; but nothing in the abstract of Armstrong's testimony explains why he was working on the fire and not watching for signal No. 448. The inspector does not accept the statements of Carroll and Armstrong that the brakes were applied immediately upon passing signal 440.

The railroad has regular examinations of enginemen for vision, color sense and hearing, and also "regular physical examinations"; and Carroll passed examinations satisfactorily in April, 1923; July, 1924; and July, 1925.

The conclusion of the report puts the responsibility on Engineman Carroll but says that "a contributing cause was the failure of Flagman Cunningham, of train No. 166, to place torpedoes on the rail as required by the rules." Had he placed torpedoes when his train was stopped at signal 440 and also when it was stopped, a little farther along, by a fusee, Engineman Carroll probably would have acted on the warning.

Engineman Carroll had begun train service as fireman in 1888. The report ends with the usual paragraph on the need of an automatic train control device.

Personals

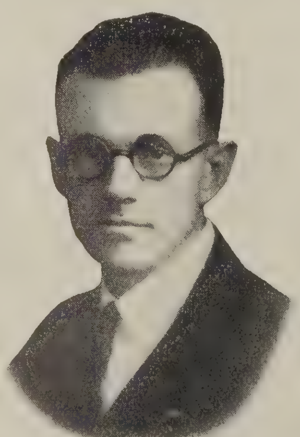
Edwin W. Petty, formerly assistant electrical engineer of the Chicago Union Station Company, has resigned to accept the position of assistant engineer, Chicago, Terminal Improvement department, Illinois Central, with headquarters in Chicago. Mr. Petty's duties involve the engineering phases of the miscellaneous light and power distribution system which is included in the Chicago terminal electrification program.

A. E. Tregenza was appointed assistant to the president of the Chicago Fuse Manufacturing Company on February 15. Mr. Tregenza, before coming to the Chicago Fuse Manufacturing Company in 1924, was general sales manager of the Economy Fuse & Manufacturing Company for twelve years, and previous to that was with the Nernst Lamp Company as a salesman in the Detroit district and later assistant district manager in the Chicago office.

A. E. Tregenza

Since joining the Chicago Fuse Manufacturing Company in 1924, when the organization was changed from a closed to an open corporation, Mr. Tregenza has taken a very prominent part in the many developments which have been made. Among these are the redesign of the Union Renewable Cartridge Fuse, which was placed on the market in 1925, the Gem Plug Fuse with the visible element, and important additions to the Company's line of switch and outlet boxes.

G. E. Brown, formerly general foreman electrician of the Northern Pacific, whose resignation on January 15 to take a position with the Westinghouse Electric & Manufacturing Company, was noted in the *Railway Electrical Engineer* of February, 1926, was graduated in June, 1913, from the Electrical Engineering Department, University of Michigan. After leaving school, Mr. Brown worked in the testing department of the General Electric Company at Schenectady, N. Y., and Pittsfield, Mass., until January, 1916, when he went as assistant general foreman electrician to the Northern Pacific, later becoming general foreman electrician. He remained in the employ of this company until he accepted his present position. He has been given charge of sales for the trans-

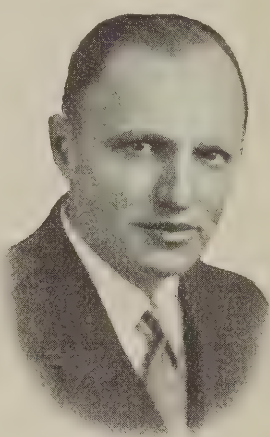


G. E. Brown

portation and industrial revision of the Westinghouse Electric & Manufacturing Company in the Minneapolis district, with headquarters at 2303 North East Kennedy street, Minneapolis, Minn.

The Graybar Electric Company, New York, formerly the supply department of the Western Electric Company, has made several changes in the organization of its department staffs as follows: W. O. Ramsburg, general service manager, now reports to the vice-president in charge of staff; G. E. Chase is broadcasting sales manager; A. J. Eaves is carrier telephone sales manager; and R. M. Hatfield is public address sales manager. C. E. Reddig has been appointed appliance engineer of the company and will report direct to the manager of the telephone and appliance department. W. A. Fouhy is the new plant engineer.

John A. Hoeveler, for the past nine years electrical and illuminating engineer of the Industrial Commission of Wisconsin, has become illuminating engineer for the Pittsburgh Reflector Company, Pittsburgh. Since graduation from the University of Wisconsin in 1911 he has been engaged in electrical and illuminating practice, first in the office of a firm of consulting engineers, then with the engineering department of a manufacturer of lighting equipment and more recently with the Industrial Commission of Wisconsin. During his term of office with the Industrial Commission he secured the enactment of the Wisconsin Industrial Lighting Code, the Wisconsin School Lighting Code (which is the only state school-lighting code in effect today), the Wisconsin Automobile Headlight Code and the Wisconsin State Electrical Code, a combined safety and fire code. In addition, he was in charge of the enforcement of these codes. Mr. Hoeveler has also been prominently identified with National Electrical Code committee work. He assisted in the drafting of the Industrial Lighting Code, the School Lighting Code, the Automobile Headlight Code, the National Electrical Code and the National Electrical Safety Code, all of which are now American engineering standards.



J. A. Hoeveler

Laurence W. Bevan was appointed general manager of the Hazard Manufacturing Company, Wilkes-Barre, Pa., February 8, 1926. Mr. Bevan is a graduate of Penn State College Class of 1912, Metallurgy Course. He entered the employ of the Hazard Manufacturing Company thirteen years ago as metallurgical engineer, and advanced successively to production engineer and assistant general manager.

Thomas A. Keefe was appointed district manager of Chicago Branch of Hazard Manufacturing Company, Wilkes-Barre, Pa., February 1, 1926. Mr. Keefe came to the Hazard Manufacturing Company in 1913 in the Pittsburgh Office as a salesman for wire rope and electrical wires. In 1918 he was appointed assistant district maanger of the Pittsburgh branch, which office he still retains in addition to now being district manager of the Chicago branch.

William S. Hart has been appointed special representative of the Hazard Manufacturing Company, Wilkes-Barre, Pa., in charge of the sale of Hazard products in the oil fields of the United States, with headquarters in Wilkes-Barre, Pa. Has been in the employ of the Hazard Manufacturing Company continuously since 1888. After serving in the factory he was placed in the Pittsburgh District office as wire rope service engineer, and a few years later was made assistant district manager. During the war period Mr. Hart acted as assistant general superintendent of the factory, and then was appointed district manager of the Chicago branch.

Trade Publications

Industrial Controller Company, Milwaukee, Wis., has recently issued a single page illustrated bulletin describing its class 8605 oil immersed automatic compensator.

The General Electric Company, Schenectady, New York, has just issued a small illustrated folder No. 67,732, describing automatic switch equipment for A. C. Railway Signal and Train Control Feeders.

Rail Bond Testers is the title of bulletin No. 200 recently issued by the Roller-Smith Company of New York. The bulletin contains eight pages and describes and illustrates the several equipments used in testing rail bonds.

Safety Hand Lamp is the title of a large illustrated folder recently issued by the Crouse-Hinds Company of Syracuse. The folder points out the various features incorporated in the design of the lamp.

The progess of electrification accomplished by the Chicago, Milwaukee & St. Paul Railway is described in the 44-page bulletin, GEA-150, just issued by the General Electric Company, Schenectady, N. Y. The profusely illustrated book takes up in detail all of the equipment, including locomotives, sub-stations, power supply, and transmission and overhead construction. In addition to photographs of equipment, there are numerous maps, diagrams and tables of specifications. Figures are presented to show the comparative cost of electric and steam operation.

The Westinghouse Electric and Manufacturing Co. has just issued Circular 7378, on Materials handling, that shows the beneficial results to be obtained in the various industries through the use of electrically driven machinery for the handling of materials.

The pages of this circular contain information and data covering the principal groups of materials handling machines, giving their uses, typical outputs and the electrical equipment best suited for their successful operation, and describes the electrical equipment that the Westinghouse Company has developed for materials handling machinery. Cranes, hoists, winches, conveyors, coal loading machines, freight elevators, trucks, locomotives and dredges are some of the types of equipment that are described and illustrated.

Railway Electrical Engineer

Volume 17 APRIL, 1926 No. 4

Location of Dipping Tanks

A dipping tank is a valuable adjunct to any electrical repair shop. There is no better or more expeditious method of giving an armature or coil winding a good protective coat of insulating varnish than dipping them in a varnish tank.

The relation of the top of the dipping tank, with regard to the surface of the floor, is a point upon which opinions differ. In places where headroom is at a premium, there is a strong incentive to place the tank so that its opening is flush with the surface of the floor or at least nearly so. Since no armature repair shop can be kept clean at all times, regardless of how much effort is made to do so, a dipping tank with its opening flush with the floor presents a very serious problem in keeping foreign materials out of the varnish. While a cover may be supplied for the tank, it is also true that there are many times when the cover will be left off. It is practically impossible to keep the varnish clean with the tank so located.

On the other hand, with very large armatures plenty of head-room must be available when the bottom of the tank rests upon the floor. Such a tank, however, is easy to keep clean. Floor sweepings of miscellaneous foreign matter can practically never get into it and the varnish will be clean and of high grade at all times.

There is perhaps a point somewhere between these two extremes which may be adopted and which will give satisfactory results. It is very certain that dirty varnish is highly undesirable and that it will pay to give serious consideration to this factor before proceeding with the installation of a dipping tank.

Lighting for Rail Motor Cars

Gas-electric and oil-electric cars are making a place for themselves on the steam railroads and it is highly probable that their use will be greatly extended. It is not necessary to use axle generators as a source of power for lighting on such cars since the exciter can be designed to generate current for lighting and control circuits as well as for excitation of the main generator.

The requirements are in general similar to those of axle lighting, but there are a number of differences. Car speed is controlled by engine speed and by generator and motor characteristics. When the power requirements are large the engine is run at high speed and conversely low power requirements call for relatively low engine speeds. Thus, as in the case of axle lighting, the generator must run at variable speeds and its operation must be automatic. A regulator is required to control the battery charging current and the voltage on the lamps must be kept at the proper value. These regulators are similar in principle to those used in the regular car lighting service, but are enough different to warrant some study by the car lighting maintainer.

In addition to the lighting of the car, the headlight must also be supplied and this considerably increases the load on the battery. When equipment is purchased it is necessary also to know whether or not trailers are to be used. It is probable that the generating equipment on the motor car will be used to light both cars. In this case the cars will require train lines and the equipment must be so designed that there will be sufficient battery and generator capacity for both cars and so that the lights in the trailer will have proper voltage. Other service conditions may also affect the design of this lighting equipment and must be carefully studied.

Headlight Maintenance Costs

The electrical men on a number of roads are now trying to develop a method for determining the costs of maintaining locomotive lighting equipment. It is hoped that the method developed will not only provide a single road with an accurate knowledge of these costs, but will also permit costs on different roads to be compared. A most important requirement in collecting this information is that the method be simple. To comply with this it has been proposed that costs include only labor and material and that these costs be taken from the time cards and the material cards. Running costs can probably be separated from maintenance costs; that is the labor and material charges for everyday work done in the roundhouse, such as inspecting, greasing, renewing lamps, etc., can probably be separated from the cost of making repairs. After these costs have been compiled for a reasonable period they can be compared on the basis of engines dispatched, engines owned, engine miles or engines in service as desired.

It should not be impossible to secure these figures and when once obtained they will disclose leaks, will make possible the comparison of work done on different divisions, will assist materially in determining to what extent damaged or worn parts should be repaired or replaced, and will undoubtedly lead to reduced headlight maintenance costs.

Some criticism of this procedure may arise from the fact that it is extremely difficult to compile cost figures which can be used to compare locomotives on different

roads or even different divisions of the same road. Much of the difficulty encountered with locomotives as a whole, however, is caused by the fact that the type of motive power used is different and the maintenance costs are effected largely by the character of the service and the physical characteristics of the division over which trains are moved. Headlight costs are to a considerable extent independent of these factors.

In addition, the train control situation is now demanding that the cost of maintaining train control equipment be determined. This will require information concerning the headlight equipment in cases where power for train control apparatus is obtained from the headlight generator. To sum up the situation, it may be said that there is an increasing need for determining locomotive lighting costs and the subject should receive concerted action which will result in having all roads compiling this information on the same basis.

More Electrical Equipment Needed

It was not so long ago that electrical apparatus on steam railroads was used to a very limited extent. Some cars were electrically lighted, a few motors were used in shops and some roads generated power for lighting passenger stations and other buildings, but for the most part the use of electrical energy was a very small factor in the everyday operation of the road.

At the same time industrial companies were beginning to make use of electrical power in every conceivable manner. Electric lighting was greatly improved in shops and factories, with the result that production was enormously increased, countless thousands of machine tools were converted to individual motor drive, electrical ovens were installed where baking formed part of the manufacturing process and in short the business of industrial manufacturing was completely revolutionized. The result is seen everywhere in the constantly reduced prices of articles which have been manufactured on a production basis.

Today the picture has changed somewhat so far as the railroads are concerned, but not nearly as much as it will be a few years hence. Slowly but surely the railroads are awakening to the fact that the introduction of electrical equipment will result in savings that can never be achieved in any other way. Within the past few years motor applications have been greatly increased, both yard and shop lighting have been improved, and electric heating equipment is beginning to be used. In a word, the railroads are beginning to apply electrical energy to their needs, but in view of the fact that their needs are so great and development in electrical industry is so rapid there is much to look forward to in the immediate future. It is true that some of the roads have done much in electrifying their shops and terminals, but these are few and are more than offset by others in which the electrical equipment is insufficient and inadequate.

There are almost boundless possibilities in the way of economies to be effected by extensive installation of electrical equipment. It is most unfortunate that more railroad managements do not recognize that better operating results are certain to follow with the addition of improved electrical facilities. In the meantime obsolete methods, tools and facilities are costing such roads thousands of dollars every year.

Electrical Equipment Pays For Itself

That the installation of electrical equipment in railroad shops is a certain method of cutting expenses is not questioned by those who have installed such apparatus. The inherent properties of electric devices are such that they lend themselves to automatic operation with such accurate and positive performance that the results obtained are most remarkable to say the least. Controlling devices which start, stop and regulate the speed of motors at any pre-determined cycle of operations seem almost to be possessed with human intelligence. The number of operations that can be repeated by a properly constructed electrical automatic installation before failure of the equipment occurs is astounding. As a specific instance it may be well to point out just what a single electrical automatic installation is doing on one road.

The matter of coal supply to a boiler room is usually not a very complicated matter but it does involve considerable labor and the yearly cost may run into a large sum, particularly with old fashioned methods.

The road in point made a study of this particular problem, going carefully into all of the factors, with the result that it was decided to install an automatic coal feeding device and under-feed stokers as against hand-firing methods previously used. The installation cost approximately $85,000. When the results of the first six months were checked up it was found that a clear saving of $10,000 had been realized over the old methods. In other words, the equipment will pay for itself in a few years.

Such an example shows unmistakably that the installation of electrical equipment may pay big dividends on the initial investment.

Power Factor Control

Controlling the power factor in a railroad shop power system frequently deserves more attention than it is given. Power factor is usually looked upon as an abstract subject of especial interest to large utility companies and the correction of power factor is usually associated with the use of the synchronous condenser—over excited synchronous motor.

The greatest need of a railroad shop power system is dependability. For this reason the induction motor is used extensively. It is a rugged dependable motor which requires a minimum of attention. Unfortunately the induction motor and other inductive devices operate at low power factor; they require a wattless magnetizing current which does no work. It simply increases line drop and line loss and requires that the power house generator and the power lines be of sufficient size to carry this extra current. If lines or machines are overloaded, the difficulty can be overcome by increasing their size. It may be, however, that it will cost less to correct the difficulty by correcting the power factor. If power is purchased, it may be the power company can offer a better rate to the consumer with a good power factor.

The outstanding advantages of the static condenser are that no attendant is needed, losses are less than one half of one per cent, they require little floor space, they are available in any size, they meet underwriters' requirements without special provisions such as transformer houses and vaults and they may be applied directly at the source of low power factor, thereby reducing line losses to a minimum.

Armature Repair Work on the Long Island

Modern Mechanical Facilities and Good Workmanship Expedite Handling of Large Volume of Maintenance

ON March 1, 1925, the shops of the Long Island Railroad at Morris Park, Long Island, were destroyed by fire and simultaneously all of the equipment used in the repair of motors was reduced to a heap of smouldering scrap. Inasmuch as the Long Island operates many miles of electrified track, through a densely populated district with frequent train service, the magnitude of such a disaster may well be imagined.

Crane House Where Cars are Removed From Their Trucks by Means of Two Traveling Cranes

The necessity for maintenance facilities to care for the large number of multiple unit cars was immediately recognized by the management who arose to the emergency by renting space in the shops of the Columbia Machine Company of Brooklyn for the continuance of the work. The new location was about three miles from the site of the destroyed buildings and arrangements were effected so speedily that none of the employees of the armature repair department lost a single day's time.

During the time the work was being done at the temporary location, the armatures were transported back and forth by the Long Island auto trucks.

The work of rebuilding the shops was immediately begun and in the month of September, the department was once more moved back to its new quarters, with greatly increased facilities for carrying on the work.

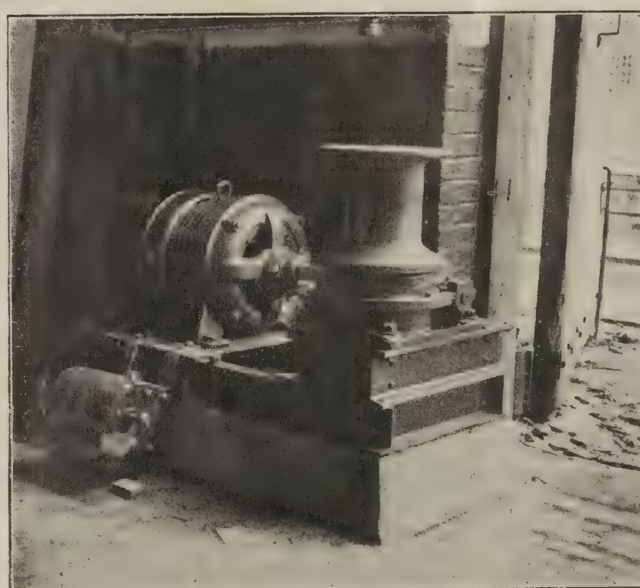
Truck Shop

One of the important features of the new shop is the largely increased space devoted to the handling of motor car trucks. The building, equipped with six tracks, each track with a capacity of four trucks, greatly speeds up the work of truck repairs and facilitates the removal of motors for dismantling. One of the most important machines in this shop is a double cutting lathe of special design which permits the turning of three bearings on the axle simultaneously. Another important machine in the truck shop is the large wheel lathe.

Four 20-ton traveling cranes operated by 220-volt a.c. motors span these tracks, and at one end of the building there is a ten-ton electric traveling crane operated from the floor by hand ropes. This latter crane runs in the same direction as the tracks and is used for carrying loads along the space where the motors are dismantled and reassembled.

Routine Handling

When a car is reported in trouble and is sent to the shop for repair, it first makes it appearance on the transfer table which brings it to the door of the crane house. Here the car is run in and lifted from its trucks, after the wiring has been disconnected from the motors. The trucks, thus released are then hauled out again upon the transfer table by means of an electric winch located near the door of the cranehouse. They are then taken to the



Electric Motor Driven Winch Used to Draw out Cars From Crane House After They Have Been Placed on Temporary Trucks—The Motor Trucks are Also Hauled Out Upon the Transfer Table With This Winch

truck shop for dismantling. Temporary trucks are placed under the car body and it is sent to the paint shop or other storage space until repair is completed to the trucks

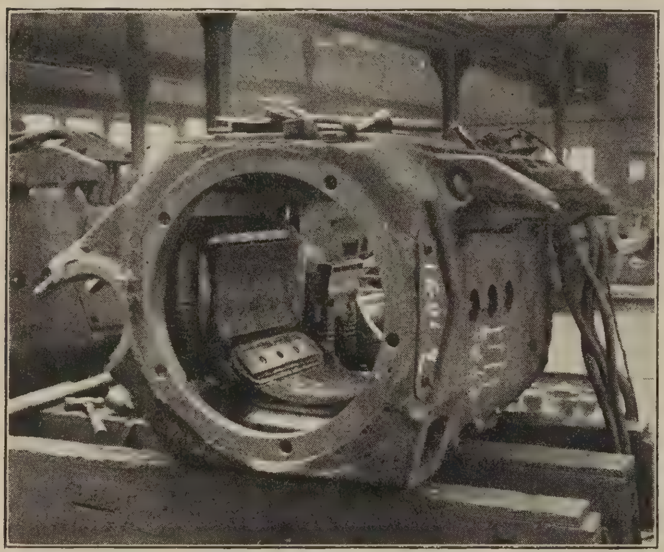
Taking Down the Motors

On arriving at the truck shop the motor shells are removed from the trucks by means of one of the 20-ton traveling cranes previously mentioned, and taken to that part of the shop where the dismantling work is done. The armatures and field coils are removed from the shells

and transferred on electrical industrial trucks to the armature room in another part of the building.

Armature Room Practice

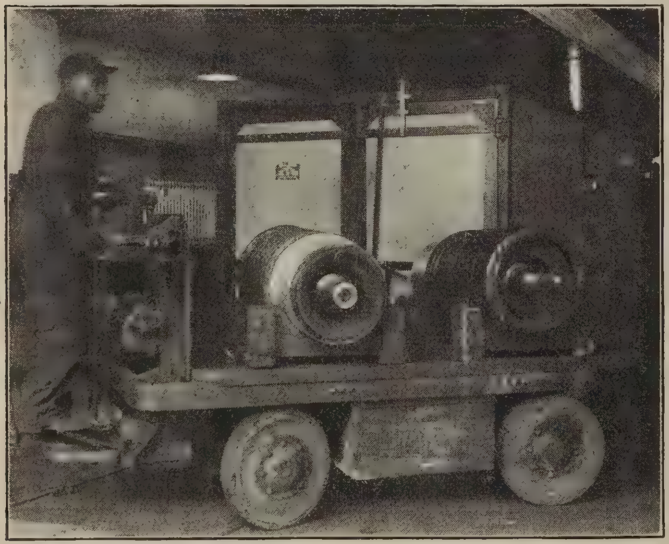
The method of handling the armature is not unlike that in many similar repair shops, but throughout their entire journey through the shop, special machinery greatly expedites the work with the result that a large volume



Dismantling and Assemblying Bench in the Truck Shop Where Armatures are Removed From the Shells—Motor Shell in Photograph Showing Field and Commutator Coils in Position, is in the Process of Assembly

of high grade maintenance work may be handled in the most efficient manner.

On their arrival in the armature room, the armatures are taken from the industrial trucks by means of a 7-ton



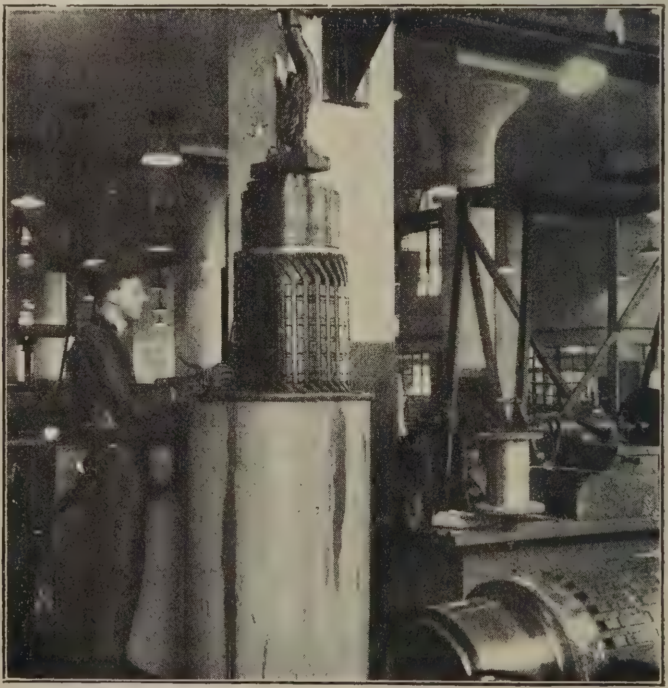
An Electrical Industrial Truck Used to Carry the Armatures Between the Truck Shop and the Armature Room—The Doors of the Electric Baking Oven are Shown in the Background

traveling crane operated by pendent ropes and placed either on the storage rack for old armatures or upon an armature winder's stand. If the machine is one which is grounded or open circuited or beyond repair, the entire armature is stripped down. The slots are filed up, the commutator ears cleaned and all surplus solder that may have found lodgement is carefully removed.

When this work has been completed, the armature is taken to the blowing-out department especially built for this purpose, where, by means of compressed air, all of

Large Cutting Knife Used to Prepare the Fibre Insulation Used in the Armature Slots Prior to Placing the Coils

the dust and dirt that has accumulated is blown out. At the point where the blowing out is done, a large suction intake is provided which is connected to the same system used in removing sawdust from the carpenter shop, and all of the dust and dirt from the armatures is carried over

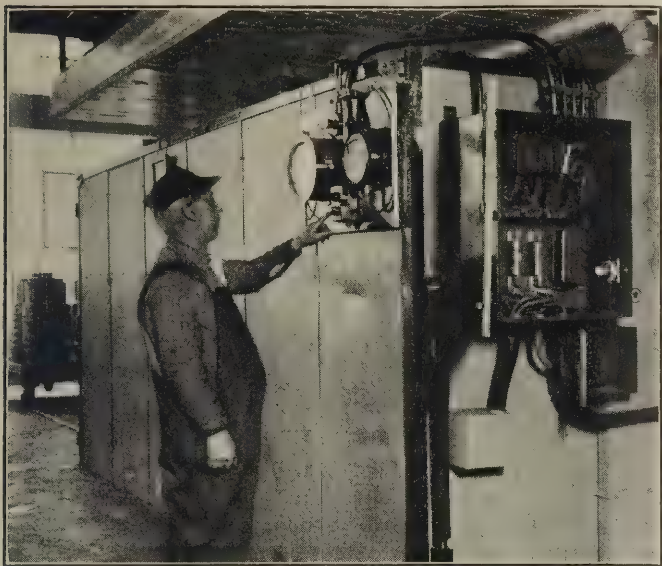


The Dipping Tank Where Armatures are Dipped After Rewinding Permits a Minimum Amount of Varnish to be Used—Being Placed Entirely Above the Floor it is Possible to Keep out all Dust and Dirt That Would Otherwise Find its Way Into the Varnish

to the boiler room. By this means the blowing room is kept clean and the air pure, instead of being filled with flying particles of mica, dust and dirt.

When this cleaning process has been completed the ar-

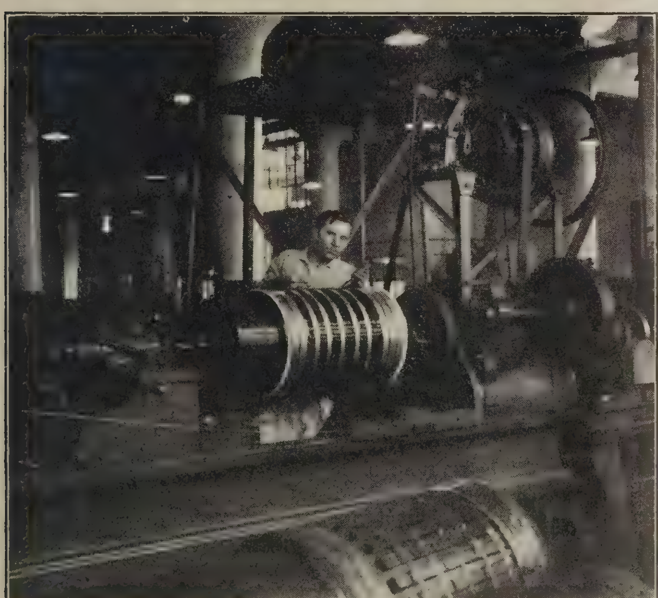
mature is returned to the winders stand for insulating and rewinding. In connection with the installation of new slot insulation, it may be of interest to note that a spe-



Electric Devices Used in Connection With the Operation of the Electric Baking Oven—Operator is Shown in the Act of Starting the Oven

cial machine has been provided for the cutting of fibre insulation used in the armature slots.

During the war armature coils were wound in the shop, but for a number of years the practice of purchasing formed coils has been in vogue as it is believed that it is more economical to purchase them than to maintain

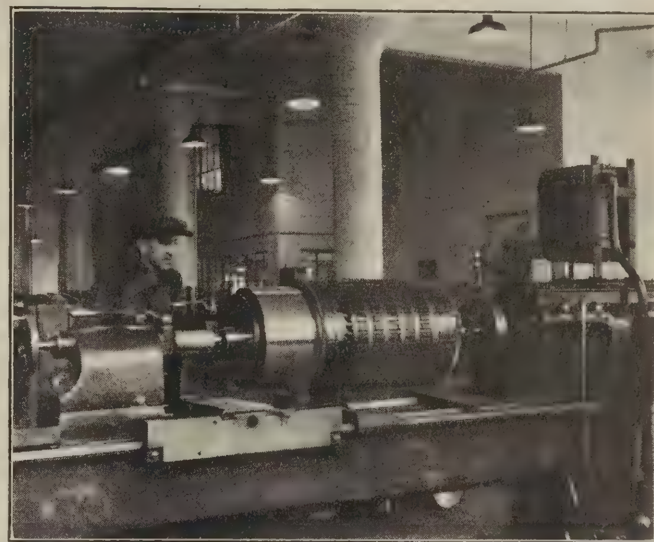


Banding Machine Where Steel Band Wires are Put on the Armature Under a Tension of 450 Pounds

a corps of coil winders. This applies to the coils used on the large 225 hp. motors which form the larger part of the repair work. Numerous smaller armatures such as are used in headlight turbines, etc., are wound in the shop.

Dipping and Baking

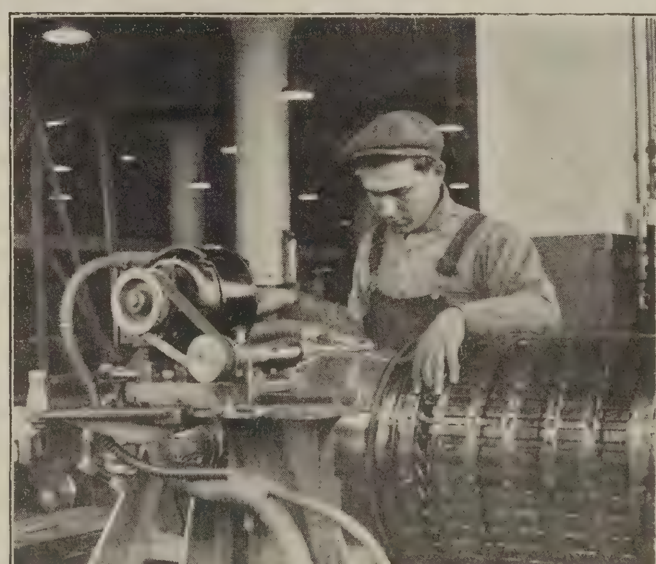
When the rewinding work is completed, the armatures are placed in a large Westinghouse Electric baking oven, type M 3 phase, 220 volt, size 114, of 42 kw. capacity, for a period of three hours. This electric oven is equipped with a thermostat inside to control the heat. The panel board on the outside consists of a recording instrument, temperature control instruments, pilot light, as well as start and stop push buttons. When the temperature of the oven is raised to the value set by the temperature control instruments, it automatically cuts off the current and



The Armature Next Goes to a Large Commutator Truing Machine Where the Commutator is Turned and the Shafts are Polished if Necessary

continues cutting in and out as often as is required to keep the temperature at the value predetermined.

A safety thermostat in the oven is supplied in addition to the regular thermostat so that in the event of this latter failing to function for any reason and refuse to drop out, the safety thermostat would cut out the *whole* circuit



Undercutting the Commutator Slots is Done on a Special Machine—All Mica and Copper Cuttings are Drawn Away Through a Vacuum Nozzle Located Near the Cutting Saw

when the temperature rose 10 degrees over the temperature at which the oven was set to operate, and would not cut in again until the apparatus was reset by hand. The capacity of the oven is such that two trucks may be

run in at once, each carrying 6 of the large 225 hp. motors standing on end.

After the armature has been in the oven for pre-heating for a period of three hours, it is removed and suspended in a dipping tank of baking varnish from the 7-ton crane, previously mentioned, for 20 or 30 minutes or until all bubbling has ceased. It is then put back into the oven a second time at a temperature of 250 degrees F. for 8 hrs. At the end of this time it is taken out and dipped again for the same length of time and once more put back in the oven from 8 to 12 hours at the same temperature.

Applying Binding Wires

On finally being removed from the oven, if the armature under consideration is newly rewound, it is immediately placed in the banding lathe where temporary wire bands are put on to pull the new coils down into place while the armature is hot. This step insures a good tight band when the permanent bands are put on.

If the armature is an old one, in for light repairs, the headings and bands are removed and the armature cleaned

Armature Windings are Subjected to High Voltage Tests of 2,000 Volts A.C. if They Have Been Entirely Rewound and 1,500 Volts if Partly Rewound

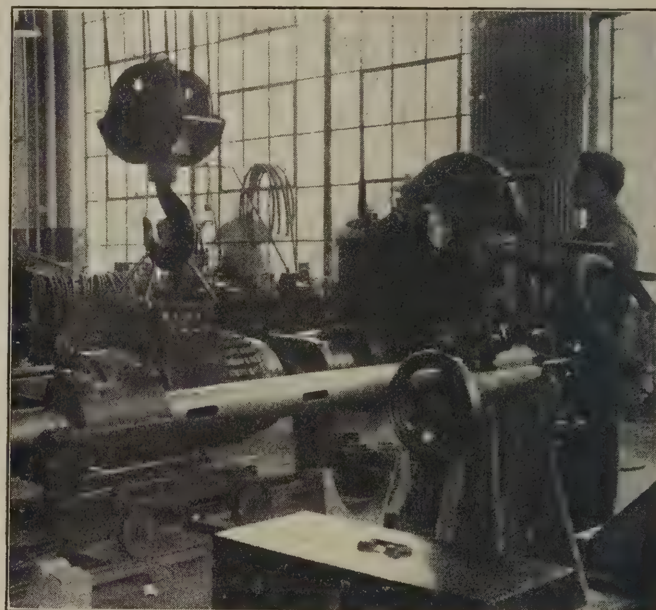
up and blown out in the same manner as described for stripped armatures.

After it has been tested and repaired, it is ready for the bake oven where it goes through the same process as newly rewound armatures. From the bake oven the armature is put into the binding lathe where bands are run on with No. 14 steel binding wire at a tension of 450 lb. These bands are soldered. In applying the binding clips which hold the binding wires, a unique method of folding one end of the clip under the binding wires is used. Three or four strands are put on first and then the extended end of the clip is folded over these and down against the armature, so that when the next band wire passes over the clip it will hold the end firmly in place. This simple method is believed to be responsible for a reduction in at least one half of the loose clip trouble.

Commutator Operations

After the binding operation is completed, the armatures are removed to a 21 in. LeBlond heavy duty commutator truing lathe where the commutators are turned. The shafts are also turned and polished if necessary.

The next operation is that of under-cutting the mica of the commutator, commonly known as slotting. This work is performed on a large commutator slotting machine built



The Large Hydraulic Press is Used in Pressing Shafts and Commutators On and Off of the Spider—This Machine Has Revolutionized the Original Method for Doing This Work

signed for this purpose. As fast as the mica and copper by the Columbia Machine Works and was especially decuttings are produced, a special vacuum arrangement carries them away so that they have no opportunity to get into the eyes or lungs of the operator.

Small Armatures are Rewound as Well as the Large Ones—Workman is Shown Driving the Coil Ends Into the Commutator Ears

While the armature is in the slotting machine, the final cord and tape band is applied. It is then given a coat of quick drying black varnish and it is once more ready to be put into service.

Voltage Testing

Before any armature is placed in service, however, a high voltage insulation test is applied to determine whether or not the insulation resistance is sufficient to meet the requirements and at the same time to be assured that there is a reasonable factor of safety in addition.

Armatures which have been completely rewound are tested at 2000 volts between windings and shaft and those which have had the windings only partly replaced are tested at 1500 volts which is approximately two and a half times normal voltage. The testing machine used for this purpose is a Westinghouse Electric & Manufacturing Company's portable equipment with a capacity of 2½ kva. This may be used either with 25 cycle or 60 cycle current using 110 or 220 volts on the primary with 6000 volts available in 30 steps on the secondary side.

The Soldering of Jumper Cables to the Connecting Heads Is a Simple Process But Very Important as the Operation of the Train Depends Entirely Upon the Good Quality and Accuracy of the Connections

Hydraulic Press

Another machine located in the armature room which frequently is of great service is the 150-ton Watson-Stillman hydraulic press used for pulling off commutators from the 225 hp. and 200 hp. motors. This operation is performed in about five or ten minutes, and the economy of the machine is immediately appreciated when it is learned that the same operation previously required four or five men, several hours, to do the same work by means of crude equipment. The machine is also used for pressing armature shafts in and out of the spiders. Some shafts will take the machine up to its full capacity before they can be released, so great is the force holding them to the spider. New shafts are pressed on with a pressure of from 60 to 65 tons.

Jumper Connections

In one part of the armature room a bench is provided for the repair of jumper connections used in connecting together the multiple unit circuits of the cars. The life of these jumpers is of uncertain length depending largely upon the treatment they receive in service. Some jumpers will last for long periods while others become defective in a very short time.

In order to tell just how long a connector has been in service a scheme of painting the malleable iron terminal heads has been devised. All jumpers repaired in 1924 are painted yellow; those repaired in 1925 are painted red; and for 1926 green will be used as the determining color. All jumpers pass through this test at least once each year.

General

For the most part, the work of the shop largely consists of the repairs to the 225 hp., 650-volt motors used as the driving power of the multiple unit equipment of the road. There are, however, 18 different types of armatures that are handled and this list includes headlight generator armatures, axle generator armatures, armatures for electric locomotives and battery cars and numerous other smaller armatures used in accessories.

During the year of 1925 the record shows a total output of armatures of all classes as 1,004. This record, however, does not include the first two months of the year as the fire destroyed the records covering this period. It is estimated, however, that the total for the year can be well assumed to be at least 200 more than the actual record shows.

The work in the armature room is done by a force of 30 men. This force takes care of all windings of armatures and repairs to all multiple unit equipment used on the multiple unit cars such as line switches, jumpers, magnet valves, resistance, grids, controllers, brush holders, main switches, heaters, etc.

The work is carried on under the supervision of W. H. Gillies, general electrical foreman with the assistance of J. S. Mills, foreman of the motor shop and J. F. Whalen, foreman of the armature room.

Rectifiers and Converters to be Used in Illinois Central Substations*

At the seven traction substations which will supply power to the overhead on the Illinois Central terminal electrification in Chicago, 1,500 volts, direct current, will be supplied in feeders specified by the railroad company to the right of way line with all protective apparatus included. The substation locations, number, size and type of units and total installed capacity are as follows:

16th Street	3	3,000	kw.	Synchronous Converters.
Brookdale (69th St.)........	2	"	"	" "
	1	"	"	Mercury Arc Rectifier.
Front Ave. (Kensington)...	2	"	"	Synchronous Converters.
Harvey	1	"	"	" Converter.
	1	"	"	Mercury Arc Rectifier.
Vollmer Road (near Olympia Fields)	1	"	"	Synchronous Converter.
	1	1,500	"	Mercury Arc Rectifier.
Cheltenham (79th St.—S. C. Branch)	2	3,000	"	Synchronous Converters.
Laflin Street (Blue Island Branch)	1	1,500	"	Mercury Arc Rectifier.

This makes a total installed capacity of 33,000 kw. in converters and 9,000 kw. in rectifiers.

The 3,000 kw. rotary converter sets will be made up of two 750 volt converter units in series. They have an

* Extract from a paper before the Western Society of Engineers, by W. M. Vandersluis, electrical engineer, Chicago Terminal Improvements, Illinois Central, Chicago.

overload capacity of 150 per cent of normal rating for two hours, which is usual for railway synchronous converters, and in order to care for very heavy current peaks occurring during starting of long trains at high acceleration rate, they will have a capacity of 300 per cent of normal load for one minute. These sets will have a maximum efficiency of approximately 94.2 per cent, which occurs at 150 per cent load.

By the use of a special automatic scheme of voltage regulation, the rotary converters will have unusually good voltage characteristics, the regulation varying from 1,525 volts at no load to 1,425 volts at 300 per cent load.

Two of the rectifiers will be 3,000 kw. units installed in substations with rotary converters. These rectifier sets will consist of 1,500 kw. 6-phase tanks in parallel, served from separate transformer banks and which may be disconnected independently from the d.c. system. These sets will have a normal rating of 3,000 kw. with an overload rating of 300 per cent of full load for one minute. The overall efficiency of the rectifier set including transformer and auxiliary losses will be a maximum of approximately 96 per cent, which occurs at full load. The characteristic of the rectifier is to maintain high efficiencies at low loads as compared with the rotary converter, the efficiency of the latter decreasing very materially as loads are decreased below normal ratings. This is brought out by the following comparisons: At 150 per cent load the rectifier efficiency is approximately 95 per cent as compared with approximately 94.2 per cent for the 3,000 kw. rotary converter; at 100 per cent load the efficiencies are approximately 96 per cent and 93.8 per cent, respectively; at 50 per cent load they are approximately 95.6 per cent and 91.1 per cent, respectively, and at the low value of 25 per cent load the rectifier efficiency is approximately 94 per cent.

Due to the widely fluctuating characteristics of the railway traction load, the individual machines will be operated at less than full load a considerable portion of the time, which makes the higher efficiency of the rectifiers at low loads particularly advantageous.

The inherent voltage regulation of the rectifier is inferior to that of the rotary converter, varying from about 1,550 volts at no load to about 1,350 volts at 300 per cent load. This will, however, be improved by use of a manually operated tap changer on the primary side of the transformer bank, which will be operated to compensate for greater voltage drops in transmission lines during peak hours and may also be operated from time to time to take care of different loadings on the rectifier set. This tap changer may be operated under load in the case of the set at Brookdale Substation, which is fed from the 12,000 volt a.c. line, but cannot be operated under load in the case of the set at the Harvey Substation, which is served by a 33,000 volt transmission system.

Two 1,500 kw. rectifier sets will be used, one of which will constitute the entire 1,500 volt d.c. supply at the Laflin Avenue Substation of the Edison Company, and the other of which will be operated in conjunction with a 3,000 kw. rotary converter in the Vollmer Road Substation by the Public Service Company. These sets will also be composed of two separate 6-phase rectifier tanks, each of which may be disconnected independently from the d.c. bus, but which will be fed from the same bank of transformers. These sets will have overload ratings of 150 per cent of full load for 20 minutes, 200 per cent load for 5 minutes and 300 per cent load momentarily (approximately one minute). The calculated efficiency of the set is a maximum of 95.8 per cent occurring at 75 per cent of full load. The inherent voltage regulation will be approximately the same as for the 3,000 kw. sets. They will, however, have special features to provide a voltage regulation curve practically identical with that of the regulated converter sets, and will also be provided with manually operated tap changers.

In deciding upon the type of conversion units, careful consideration was given to motor-generator sets as well as synchronous converters. In view of the higher efficiency of the converters and rectifiers, the guarantees of the manufacturers as to stability and the recent developments in protective apparatus, it was finally agreed that converters and rectifiers would be acceptable.

The installation of Mercury Arc Rectifiers is the first of this magnitude in the United States, although their use abroad is extensive. A requirement of the agreement provides for a spare unit in each substation, except Laflin street, initially, and it will be noted that the reserve capacity is largely in rectifiers. Undoubtedly they will be used as much as possible on account of their higher efficiency.

In Montreal Harbor

Looking Eastward at the Train Shed of the D. L. & W. R. R. at Hoboken, N. J.

Testing of Car Lighting Panels on the D. L. & W.

A Detail Description of Methods Used Which Have Been Found to Give Satisfactory Results

By Geo. W. Wall
Car Lighting Foreman, Delaware, Lackawanna & Western R. R.

IN the February issue of the *Railway Electrical Engineer* there appeared an article describing methods involved in general overhauling of car lighting equipment on the Lackawanna at Hoboken. Further information concerning the practices in vogue in the car lighting department of this road are of interest, particularly the activities of the inside man.

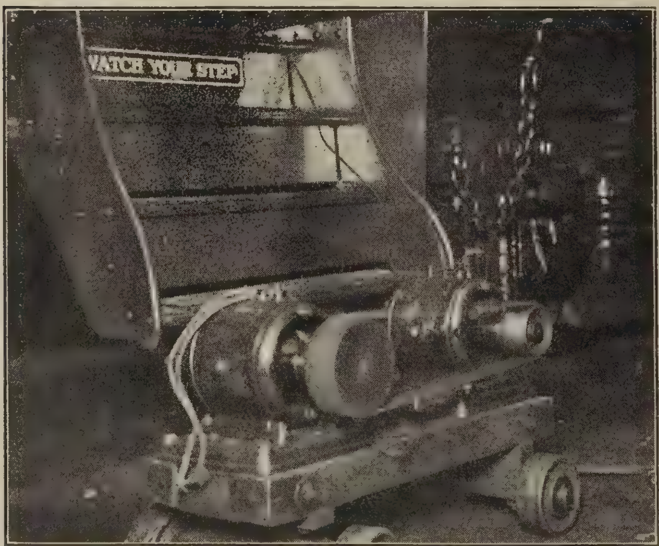
The inside man has more detail to handle as he overhauls the panels and in addition goes over the fixtures, switch board, train lines and such miscellaneous equipment as may be used on the car. He checks over the lamp and fuse equipment, cleans the train line receptacles, adjusts switches on the distributing panel and renews any or all of the main fuses which show evidence of crystallization as they are by no means dependable as protective devices unless they will blow at the proper overload.

The first step taken in the overhauling is to test out the whole wiring system for grounds or short circuits. If ok. a motor-generator set is connected to the generator panel, in place of the regular car lighting machine. The motor of the testing set is plugged into a 60-volt charging circuit and by means of an adjustable resistance the motor is operated at a speed sufficient to drive the generator and provide current to operate the panel, making it regulate as it would on the road in service. The voltage setting of the automatic switch and the floating voltage for which the panel is set are the most important factors of regulation. The current setting is important as it protects the generator from overload, but the voltage setting is even more important. It determines the output to battery and lamps and is always operating while the generator is above cutting-in speed, whereas the current control is in operation only when the generator output tends to rise above a fixed value, gradually transferring all control to the voltage limiting part of the regulator as the current demand falls below the full load setting of the panel. Proper voltage regulation not only protects the battery from overcharge or undercharge but relieves the lamp regulator of the necessity of absorbing excess wattage and permits operation well within its limits, eliminating tendency to flickering lights, carbon deterioration, etc.

Immediately upon hooking up the set, a test of the automatic switch and maximum voltage setting is made without waiting for the temperature of the coils to reach normal. A temperature test of the coil is taken and this reading corrected to 80 degrees F. for comparison with the last previous test. The resistance in the motor circuit is slowly reduced, speeding up the generator so that voltage is impressed on the regulator just as it would occur in service. The regulator under this method operates as though it were in actual service and false indications are not given. The motor generator set makes a very satisfactory arrangement for testing although it is limited in its ability to operate the panel as it is too small to give an indication of the current setting. On the other hand, it has been our experience that current settings are not affected in service to any great extent by service conditions.

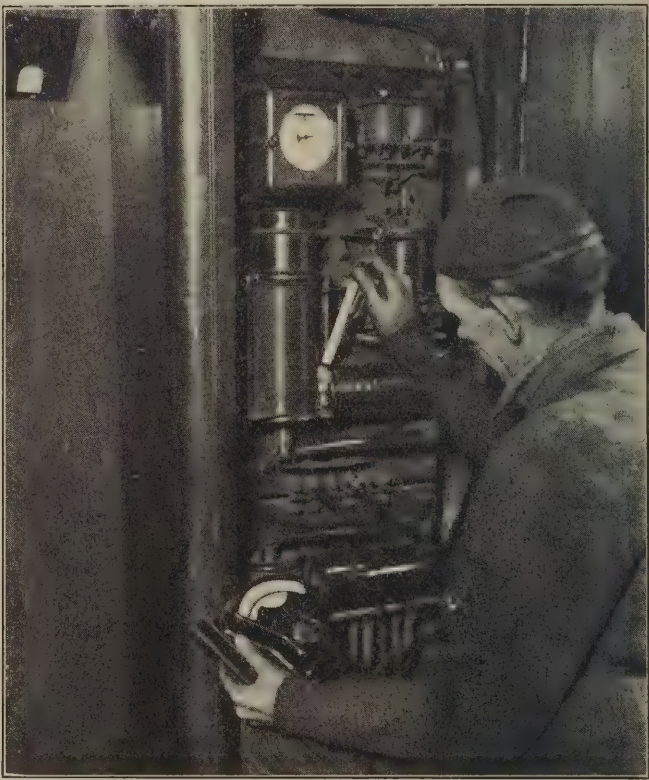
The motor generator set has several advantages over the method of hooking two batteries in series through the train line, as is often done for testing. The testing may be done at any time during the overhauling without waiting for the battery to be installed; it is not necessary to have two cars together and most important of all, the regulator does not have to be manipulated by hand, a practice productive of many false indications. The practice of testing by means of train lining and arranging connections to get two batteries in series does very well as a check for yard work if no other facility is at hand, but at best is not satisfactory as it is usually necessary to use the field pile as a rheostat. When this is done the high voltage impressed on this pile may cause it to operate satisfactorily under this test even though there may be considerably more resistance in the pile and its connections than normal. If the resistance in this circuit is not kept down to a minimum the cutting-in and full load speed of the equipment may be seriously affected. In fact, in several instances, the resistance of the carbon pile and connections has been found to be excessive to the point of raising the cutting-in speed above the point where full output should have been reached.

The practice of raising or lowering the levers by hand when testing is very inefficient and about as misleading as an open circuit voltage reading of a battery. Too much power resides in the hand of the test operator and he unwittingly exerts sufficient power to overcome friction due to slightly bent plunger stems, sticking dash pots, dirt and such defects. When the regulator is caused to function under test just as it does on the road, a real test result is given and friction due to any cause becomes evident very quickly. A regulator should operate at the same point as in a previous test unless there is wear or some defect which has developed in the intervening time. On the road, the plungers are raised by the current against the force of gravity or springs or a combination of both, and should quickly operate to hold the correct voltage with slight variations above or below the desired point as long as the train is at or above the regulating speed. Duplicating this condition as closely as possible in shop tests assures proper adjustment and satisfactory service operation.



Motor-Generator Testing Set Used to Operate Panel for Testing and Adjustments when the Car Is Standing

After the initial test results are recorded, the electrician goes about the other work on the car and allows the panel under test to operate for about an hour in order that it may heat up to 80 deg. or more. Then the voltage applied is varied up and down from the setting for that particular panel by increasing or decreasing the speed of the test set, slowly at first to determine whether the regulator quickly compensates for the varying speed, and then in quick jumps to determine whether it will operate quickly enough to prevent lamp destruction in case of sudden opening of the battery circuit at high train speed. Particular attention is paid to the action of the dash pot to observe whether there is any tendency toward hunting when a sudden change takes place in the voltage impressed on the coil.

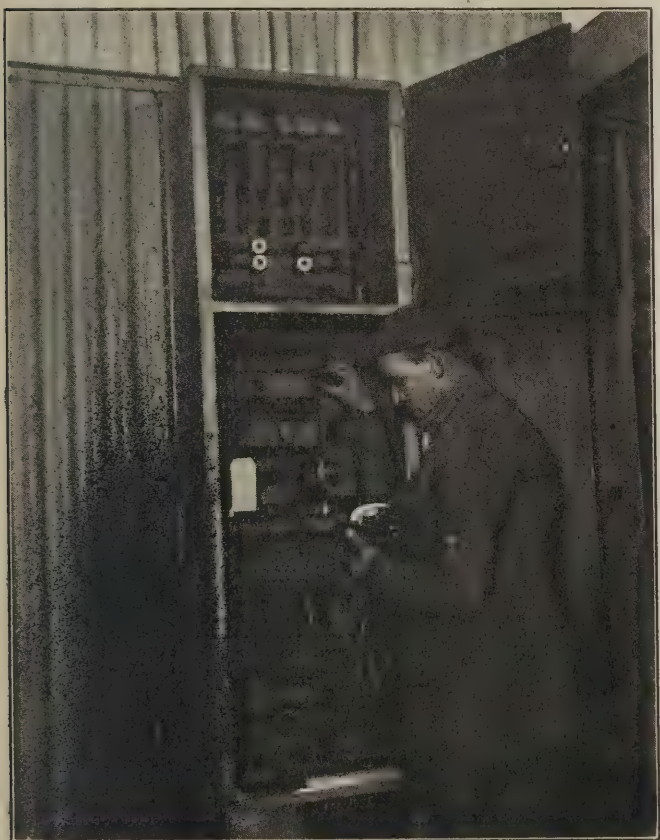


Temperatures of Coils Are Taken to Determine Any Abnormal Heating

If the action of the regulator is satisfactory, the test set is stopped and the panel given a thorough cleaning and adjusting of all working parts. The field pile is removed and vigorously shaken to dislodge dust or loose carbon partiles. The practice of rubbing the carbons together to clean them is frowned upon as it tends to make the carbons too smooth and flat and the pile loses the resiliency required to vary its resistance between wider limits without opening at some point sufficiently to cause arcing and consequent burning of the carbons, thus rendering them useless. A few carbons are subjected to a slight bending strain to determine if they are still springy and lively enough to go back into service, thrust carbons and plates are removed and cleaned to cut down excess resistance at this point. The surface of the thrust carbon on the side toward the thrust plate should be made as smooth as possible so that there is the least possible resistance at these points, providing a low resistance contact and cutting down the tendency to overheat. All lever and plunger guides are examined to detect wear or flat spots

which might add to the friction and interfere with regulation. In the case of liquid pots, the liquid is thrown away and the pot cleaned out and steamed to remove all traces of dirt or scale. Air pots are taken apart and examined for scored or stuck pistons.

The automatic switch contacts, both carbon and copper, come in for close inspection to determine whether the carbon has at least 1/16 in. less gap than the ccpper and the copper brushes. The contacts are checked for wipe and large contact surface when pulled up tight so there



Taking the Voltage Drop Across a Carbon Pile of a Panel Located in a Baggage Car

may be ample carrying capacity to prevent undue heating and to relieve the carbons of as much of the current carrying duty as possible. This stops the rapid deterioration of the carbon contacts which are supposed to take the "break" only, but which occasionally will be found to carry a surprisingly large percentage of the current output if the adjustment of the copper brush is not correct.

The current regulating mechanism is checked for friction and thoroughly cleaned. The attention required by this part of the regulator is not quite as rigid as the rest as a few amperes variation is not so important inasmuch as the plunger is entirely out of action a very large percentage of the time and excess current of sufficiently high values to injure the generator would overcome considerable friction and correct the regulation long before any damage was done.

After the regulator has been cleaned and all mechanical adjustment made, the test set is again hooked on and a final test made. The switch closing and opening voltage is checked and the maximum generator voltage operation noted. The test set is then held at a fixed voltage, and the lever arms working on the field carbon pile are operated to compress and release the pile. This is to determine if there is sufficient resiliency to the pile, so that it will not open the field circuit or cause uneven voltage or current due to lack of travel to interpose a considerably increased resistance before opening the circuit.

The record of the initial and final tests are preserved for comparison with previous and future tests to determine the reliability of the apparatus as a regulator over a long period of time.

A point is made of having the battery installed by this time and the test and overhauling of the lamp regulator is in order. All lights are thrown on and the battery and lamp voltage noted. Careful examination for mechanical defects is made and the regulator cleaned. The control circuit is opened by removing the unit and the drop through the regulator taken at the terminals and also the drop in the carbon pile taken at the end plates. On a 25 ampere load this drop should not exceed 1.75 volts at the terminals and one volt or under in the piles themselves. Any excess over these figures would indicate high resistance at some point. All end plates to carbon, and plate to flexible, as well as flexible to terminal are checked

Testing for Grounds and Short Circuits

with the voltmeter on low reading. This point of high resistance may easily be determined in this manner and corrected and the regulator made ready for testing as to voltage operation on the road. All that is necessary for this test is to put the car on charge to impress high voltage on the battery circuit which gives the same condition as though it were operating in service. The voltage at which the lamps will burn is determined in this manner and corrective adjustments made if required.

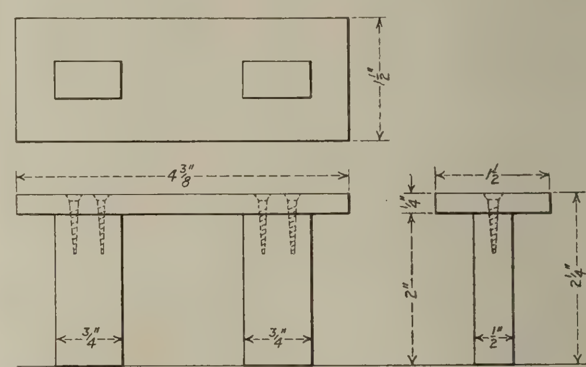
Train lines have proved of great service in various ways and all cars are so equipped. While the need of

train lines is not of frequent occurrence they must be maintained in good order ready for use at any time. When the occasion arrives when train lining must be resorted to it was sometimes found that the long exposure of the receptacle to the action of gases and corrosive effects of various kinds as well as the accumulation of dirt and cinders was sufficient to prevent the flow of current or at least caused considerable voltage drop at the receptacle. Various methods were introduced to get around the difficulty, among them the old trick of putting the plug of the connector under the faucet of the water tank before putting it into the receptacle. The water soaked up the dirt and corrosion and usually it was possible to establish the circuit, although there might still be considerable drop in voltage due to the poor contact at the receptacles. Sandpapering the interior contacts of the receptacle was satisfactory but did not last and had to be repeated often. Finally, the trouble was eliminated by means of a wooden dummy plug made up to fit the receptacle and held in place by screwing up the thumb nut. The contacts are cleaned of all foreign matter and the dummy put in place and when removed after long periods the contacts are found as clean as when the dummy was applied. When it is necessary to train-line a car, the trainman removes the dummy and places it in the switch locker, its presence then serving notice on the electrical

Photograph Showing Actual Appearance of the Train Line Dummy Plug

inspector that the car has been train lined even if no other evidence is present. Very little cleaning of the contacts is necessary since the dummy plug was adopted and consequently the contacts are not worn down to the breaking point as was quite often the case previously. Having attended to the foregoing and both inside and outside workmen are finished, the equipment is motored. If the switch picks up readily the equipment is presumed to be in working condition and service records support this presumption. The switches are all thrown in with the exception of the battery switch and a final test made for grounds or short circuits and if ok., the car is released for service. The battery circuit is tested separately as it is so often found to ring to ground even though there may be a new floor in the box and the trays themselves cleaned and painted. Such grounds as are found in the battery circuit are usually of such high resistance that the leak is negligible and the adoption of rubber jars is wiping out this source of trouble to a great extent.

It is, of course, quite possible to go to greater lengths in testing and overhauling the equipment and in the early days of axle generator lighting such extreme care was necessary, but today we take advantage of the advances made in electrical and mechanical design and pass up various tests and details of overhauling as have proved unnecessary. The parts of the equipment which are subject to wear and points at which trouble develops in service receive the closest attention, and other parts which



Sketch Showing Dimensions of Train Line Dummy Plug — These Plugs Keep the Train Line Receptacles Clear of Dirt

give practically no trouble in service are subjected to very slight disturbance. Panels are never removed to inspect the back connections as loose connections are extremely rare. It is easier and cheaper to put the voltmeter on low reading scale and use it in exploring points across switch clips, terminals, fuses, etc. When excessive drop is found the affected part may be repaired without waste of time in removing apparatus again and again only to find it in good order. Poor connections, if serious, heat up the parts in trouble and expose themselves quickly enough when the electrician runs his hand over the parts, which he may do on 30-volt circuits with entire safety. The voltmeter shows up excess drop and the remedy is usually evident on inspection of the part affected.

Train Control Orders Modified

The request of the Great Northern that the order of the Interstate Commerce Commission requiring it to install automatic train control be modified, so as to permit an installation between New Rockford, N. D., and Minot, N. D., instead of between Williston, N. D., and Wolf Point, Mont., was granted in an order made public on March 30. The commission also exempted from the application of the order the locomotives of the Devil's Lake district, which run for about four miles over the double track between Surrey and Minot, N. D.

The Interstate Commerce Commission has granted a petition of the Lehigh Valley, the Reading and the Baltimore & Ohio for an extension of time to September 1 for the fulfillment of the commission's automatic train control order as to the Lehigh Valley.

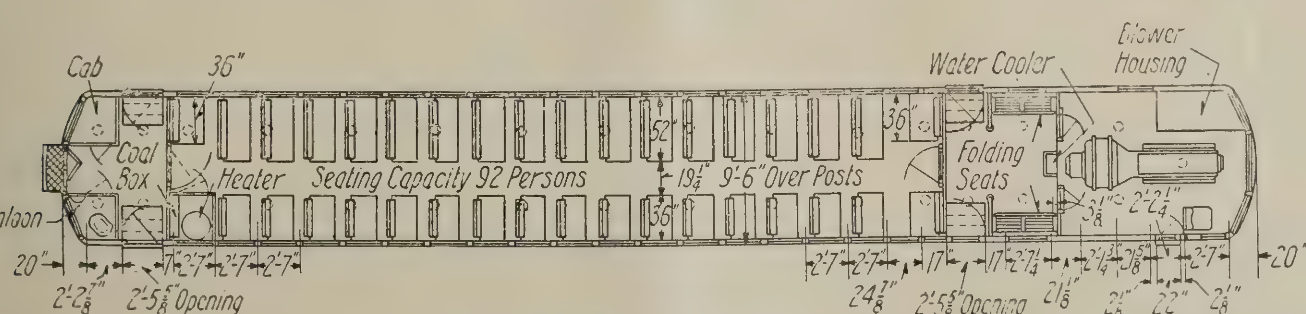
Brill-Westinghouse Gas-Electric Car for the Boston & Maine

A 73-Foot Gas Electric Car for Boston & Maine

Control Circuits and 760-Watt Lighting Load Supplied by 215 Ampere Hour Battery and 2.5 Kilowatt Exciter

A NEW gas-electric car which is 73 feet long and has a seating capacity of 92 persons has just been delivered to the Boston & Maine. The weight of the car without load is 110,000 lb. and the estimated average load is 14,000 lb. The engine-generator unit is mounted at the forward end in a 11-ft. 6-in. compartment which also houses all of the engine auxiliary apparatus and the control equipment. The operator's seat and controls are located at the forward right-hand side of this compartment. The control is arranged for double-end operation. The entrance to this compartment is through end center entrance swing doors that open at the rear end onto the vestibule and at the front end into a small baggage or storage compartment.

The baggage compartment is fitted with two folding seats and can be used as a smoking compartment. Four side entrance doors are provided for the passengers and one for the operator. The rear vestibule is fitted with two doors and the storage room with two. The operator's door is located at the rear of his seat in the engine room.



Floor Plan of the 73-Ft. Car

The other control cab is located at the rear of the car on the right-hand side. This second control cab is entirely enclosed. The car ends are rounded and fitted with three clear-view glass windows at the front end and two windows with a center folding door at the rear end.

The main passenger compartment is 46 ft. 6 in. long and is fitted with 35 seats for 84 passengers. The aisle is located slightly off the center line of the car as the seats on one side are capable of holding three persons and on the other only two. This type of seating arrangement gives an unusually low ratio of floor area to seated passengers and, hence, is a very economical type of design. A toilet is located on the rear vestibule. The car is heated by a hot water circulating system, the coal heater being located at the rear of the main passenger compartment. A 600-volt electric heating unit is used in the rear control cab.

The car is mounted on standard high-speed MCB Brill trucks. The electric traction motors are mounted on the forward truck which has a wheelbase of 7 ft. 6 in. The wheelbase of the trailing truck is 7 ft. The wheel diameter is 33 in. The truck center distance is 54 ft. 6 in.

The car body is of light-weight steel with straight sides and arched type roof. The underframe consists of two

12-in. channels to which are riveted the cross members supporting the car body. The posts are of spring brass. The car body construction and the well equalized trucks give the car excellent riding qualities. An added feature of this car are roller bearings that greatly reduce the friction at starting and insure very reliable operation.

The motive power equipment consists of a Brill-Westinghouse, 250-hp. six-cylinder gasoline engine driving a 160-kw. generator. The power is supplied to two 140-hp., 600-volt traction motors mounted on the forward truck.

Lighting Equipment

The car is equipped with a 32-volt, 215 ampere-hour storage battery consisting of 16 Exide MVE-13-2 cells,

The Pasenger Compartment

arranged 2 cells per tray. This battery affords the current for car lights, for engine starting motors, and for excitation of the exciter field. It is kept charged by the exciter through a regulator of the carbon pole type. The rating of the exciter is 2.5, kw., 66 amp., 38 volts, 1,100 r.p.m. The device which regulates charge to the battery is a Safety type F battery charge control rated at 40 volts and 35 amperes.

Lamp voltage is maintained at the proper value by a Safety type F lamp regulator rated at 40 volts and 50 amperes. The passenger compartment is lighted by nineteen 15-watt lamps in opal reflectors arranged in two rows over the seats. There are four similar lighting units in the baggage compartment, three lights in the engine room, two in the rear vestibule and one each in the toilet and operator's cab. The classification and marker lights are provided with electric lamps and there is a headlight mounted on the roof at each and of the car which is equipped with a standard 250-watt lamp. The operator's window at each end of the car is supplied with an automatic electric window wiper.

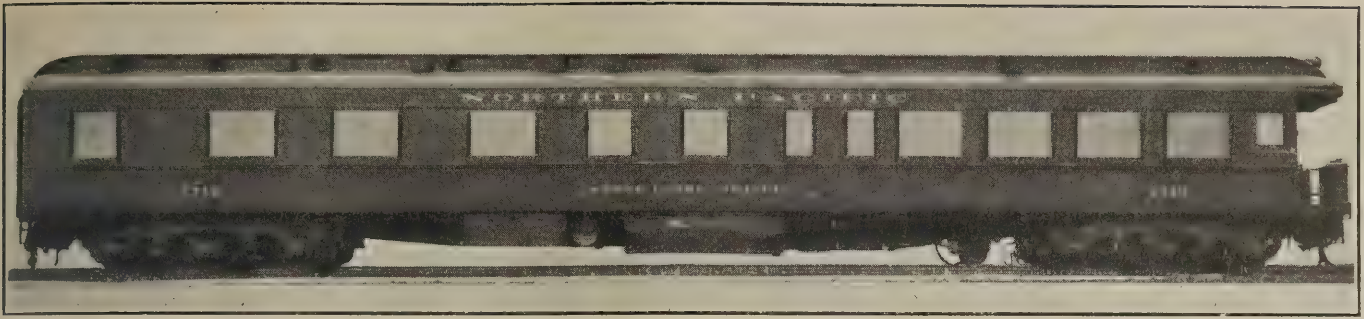
Car Performance

It is estimated that all of the principal operating costs of this single car unit will be lower than those for the steam train it is replacing. Fuel costs will be lower as the total train weight per passenger seat is much lower. Labor costs will be lower as there is no need for an operator in the engine room corresponding to the fireman on the steam train. It is also expected that maintenance costs will be much lower than those for the replaced steam train as overhauls will be more infrequent. The feature of continuous service with infrequent inspection permits the use of the car on a long daily run not possible with a single steam locomotive. The new gas-electric car also eliminates the coaling and watering facilities necessary with the steam service.

Until recently only sixty-foot cars, and smaller ones, have been constructed to meet various service conditions. Such units as these have been built with power plant capacity for either single car or trailer operation. The smaller car when suitable for trailer operation is a very flexible unit, but not the most economical unless the trailer operation is continuous. Where service conditions are such that the loads are small and practically constant, and where the capacity of the 73-ft. car is adequate for the service, there is no doubt that it will prove to be the most economical as its operating costs will prove lower than the single motor car unit with a trailer or the steam train.

The complete car was assembled by the J. G. Brill Company. The Westinghouse Electric & Manufacturing Company furnished the motive power equipment. It is one of three purchased by the Boston & Maine from the Brill and Westinghouse Companies, the other two units being standard 60-ft. cars. Five of the 73-ft. cars have been ordered by the New York, New Haven & Hartford

Brill-Westinghouse, Gasoline-Electric Switching Locomotive in Service on the Long Island



New Northern Pacific Observation-Club Car for the North Coast Limited

Observation-Club Cars for Northern Pacific

Unusually Complete Electrical Appointments Include Many Features Other Than Lighting

THE Northern Pacific is now receiving from the Pullman Car & Manufacturing Company 10 steel observation-club cars, in the design and interior arrangement of which there are several unusual features. These cars, beginning with April 1, will be placed in service between Chicago and Seattle, Wash., on this road's North Coast Limited trains.

In order to provide room for unusually complete toilet and club lounging facilities in a single car, these cars have been built with an overall length of 83 ft. and complete utilization of the possibilities of this length has been effected by building the cars without front vestibules, entrance being gained through the adjoining Pullman cars. Another unusual feature is the elimination of passenger steps and trap doors from the observation platform at the rear of the car in order that there be no interference with the complete use of the observation platform at all times by the passengers on the train.

Complete Harmony of Decorative Details, Variety in the Selection of Furniture and the Use of Table Reading Lamps Give Character to This Observation Room

How the floor space of the car has been utilized is clearly indicated in the floor plan drawing, from which it will be seen that, starting at the forward end of the car, behind the Baker heater compartment, are the ladies' rooms, a single entrance from the corridor communicating with complete shower bath and toilet facilities and a lounging room, the long sofa in which may be made up into a sofa berth. Mirrors are provided in the wall over the lounge sofa and over the dressing table and a full length mirror is placed in the wall between the lounging room and the corridor.

Adjoining the women's rooms are two men's smoking rooms, each equipped with six leather upholstered chairs and a card table. An attractive feature of these rooms is found in the glass panels in the corridor partition on both sides of the doorway into each of these rooms which enable the occupants to see out of both sides of the car. Adjoining the second smoking room is the men's toilet, accessible from the corridor, and next is a well-appointed barber shop, through which access is had to the men's shower bath. Behind the large mirror in the side of the barber shop opposite the shower bath is an upper berth for the use of the attendant. The barber shop and shower are finished in white enamel and the barber shop is completely and conveniently equipped with all necessary fixtures, including a white porcelain pedestal washstand and a full size barber chair. The buffet, which occupies the last compartment adjoining the observation room, is equipped with the essential apparatus for dispensing soda water drinks and other cold beverages and is well supplied with refrigerator and locker space.

In the observation room which is slightly over 25 ft. in length, there is a marked departure from the conventional type and arrangement of furniture. It will be seen that on either side of the car has been placed a small table and reading lamp and that on one side is a capacious sofa. Across the car from the sofa is a Victor orthophonic phonograph in a cabinet which harmonized in style and finish with the other furnishings and decorations.

The comfort and general attractiveness of this room is further enhanced by the use of chairs of three distinct types each differing from the others in appearance so markedly that the monotony of the customary rows of chairs in observation and club cars is completely

eliminated. The possibility of finding a comfortable seat has also been increased by slight variations in height or tilt of those chairs which otherwise are identical in appearance.

From an inspection of the car, it at once becomes evident that its interior decoration and furnishing was not left to the engineering designer. As the keynote of the decoration of the observation room, the men's smoking rooms and the women's lounging room, the Adam motif was selected and this has been applied to produce a charming effect of harmony and good taste. The interior is finished in French walnut decorated with a color scheme in decalcomania which harmonizes with the soft colors of the carpet specially woven to conform in figure with the prevailing scheme of decoration.

The windows are unusually large, both in height and width, and a person of ordinary height can readily see out of the car while standing erect. The window at the rear end of the observation room is said to be the largest ever used in car construction, measuring 4 ft. 2 in. in height by 5 ft. in width. The windows throughout are of double sash construction and in winter time a third sash is applied to the outside of the car.

These cars, which are 83 ft. in over all length, measure 77 ft. 3 in. over the end sills and weigh 170,500 lb. The trucks, which are spaced 58 ft. 5½ in. between centers, are cast steel of the six-wheel, top equalized type. They are equipped with the Miner safety locking device, Stucki side bearings and Simplex clasp brakes.

The cars are fitted with the Miner friction draft gear and buffing device, and the Pullman coupler centering and carrying device. Other special equipment of the cars includes Utility ventilators on five of the cars and Mudge ventilators on the other five, with exhaust fan ventilators in the ladies' room and the two men's smoking rooms. The brakes are of the Westinghouse U.C. type with two 14-in. cylinders.

Electrical Equipment

Current is supplied to the car from a Safety 4 kw., 40 volt, body hung generator mounted on the center line of the car. This generator is driven by a 5 in. belt from a barrel type axle pulley. It may be noted that 64-volt head end lighting has been standard on the Northern Pacific, but the road has recently decided to equip trains Nos. 1, 2, 3 and 4 with 32-volt axle lighting.

The generator regulators are of the standard Safety type such as is applied to general service cars of the Pullman Company, while the lamp regulators are of the Safety type F, of 50 amperes capacity.

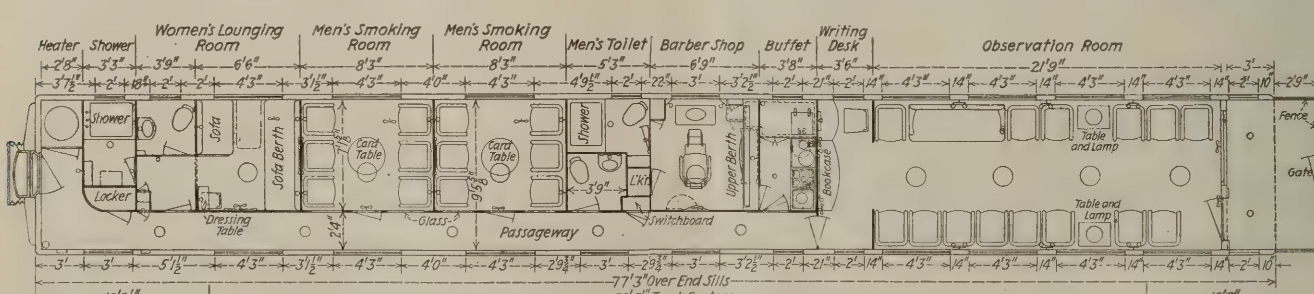
Five of the 10 cars are equipped with Putnam 16 cell storage batteries, type CLEF and of 360 ampere hours capacity. The other five are equipped with Electric Storage Battery Company's 16-cell Exide batteries, type EP-15 with a capacity of 350 ampere hours. Both types of batteries are housed in rubber jars.

The switch panels were furnished by the Crouse-Hinds Company and are equipped with three knife switches; one for the train line, one for the battery and one for the lights. In addition there are 10 branch circuits which are operated by push buttons. Gang switches are located in the rooms for local control of lights. The train wires consist of two No. 2 conductors.

The Observation Platform Is Without Trap Doors, Stirrup Steps Being Provided for the Trainmen—The Searchlight Over the Hood Is for the Pleasure of the Passengers

There are two charging receptacles, one on each side of the car. These are Anderson, type C, swivel receptacles of 100 amperes capacity.

On the observation platform are located two receptacles, one on either side for connection to electric markers, and a third receptacle in the observation hand rail for connection to an electric sign.



The Floor Plan Arrangement of the Northern Pacific Observation-Club Cars

Lighting Arrangements

The Safety Car Heating & Lighting Company furnished all of the interior lighting fixtures. The fixtures were designed and manufactured especially for these cars with ornamentation and coloring in harmony with the Adam motif. The finishing on the metal portions is stained brass accentuated with delicate light colors includ-

ing jade, new blue and oxblood. Center deck lamps, of which there are eight per car, are special center lamps No. 19456 with No. 51646 bowls. Four of these are located in the observation room, one in the barber shop, one in each of the men's smoking rooms and one in the ladies' lounging room. Each of these lamps is equipped with a 100-watt, PS-25 clear bulb.

Lower deck fixtures No. 9054 with nickel finish and No. 53213 bowls are used in the buffet, in the men's bath and in the ladies' bath. The buffet fixtures use 50-watt, PS-20 clear bulbs, while those in the bath rooms are 25-watt, S-17 bulb each. There are 5 other lower deck lights in the passage way and these are No. 19461 type with No. 56334 bowl. Each is equipped with a 25-watt, S-17 clear bulb.

In the observation room there are seven 2-light brackets No. 19457 special, each of which is furnished with a 25-watt, S-17 clear bulb. There is one light bracket over the desk in the observation room of the No. 19472 type in which a 25-watt, G-18½ clear bulb is used. There are also two other one light brackets in the observation room of the No. 19458 special type. The barber shop is equipped with two brackets of this type except that they are nickel plated and four others are used in each of the smoking rooms. Twenty-five watt, S-17 bulbs are used in all of these.

In the ladies' lounging room 5 candlebra brackets are installed. These are of the No. 19460 type with parchment shades, and each is furnished with a 15-watt G-18½ clear bulb.

The ladies' toilet and ladies' bath, and the men's toilet and men's bath are each furnished with one 25-watt, S-17 clear bulb mounted in one light bracket of the No. 3844 nickel finish with No. 9632 shades.

One No. 1749 pendant fixture with nickel finish, supplied with a 15-watt, G-18½ clear bulb is mounted in the barber shop.

On the two tables in the observation room special table lamps No. 19459 with 25-watt, S-19 bulbs are used and these add materially to the home-like appearance of the room. It is interesting to note that each of these lamps weigh 60 pounds and are said to have demonstrated their stability even under severe switching impacts.

Two 15-watt, G-18½ clear bulbs are located on the observation platform and these are housed in a No. 9060 vestibule lamp.

The switchboard locker is equipped with one 15-watt, G-18½ clear bulb mounted in a wall socket, and one 15-watt, G-18½ green colored bulb used as a generator pilot lamp. This latter is a 64-volt lamp while all of the others are for 32-volt operation. All lamps are equipped with medium screw base.

A floodlighting unit containing a 250-watt projection type lamp is mounted on the roof at the rear of the car. Its elevation and direction are controlled by a lever hand wheel from the observation platform so that passengers can use it at night to view the passing scenery.

Electrical Fixtures Other Than Lighting

Westinghouse Electric & Manufacturing Company's railway type bracket fans are installed on the cars. Four of these are in the observation room, one in the barber shop and one each in the men's smoking room and in the ladies' lounging room. The smoking rooms and ladies' lounging rooms are also equipped with electric motor driven exhaust fans.

Each car is supplied with two curling irons, one electric hair drier and one Western Electric Company's No. 12 vacuum cleaner and one 12 pound American Beauty pressing iron.

Telephone service is furnished by a Western Electric Company's No. 1020 AL desk type telephone which can be brought out of the locker and plugged into a jack located in the writing desk in the observation room when required.

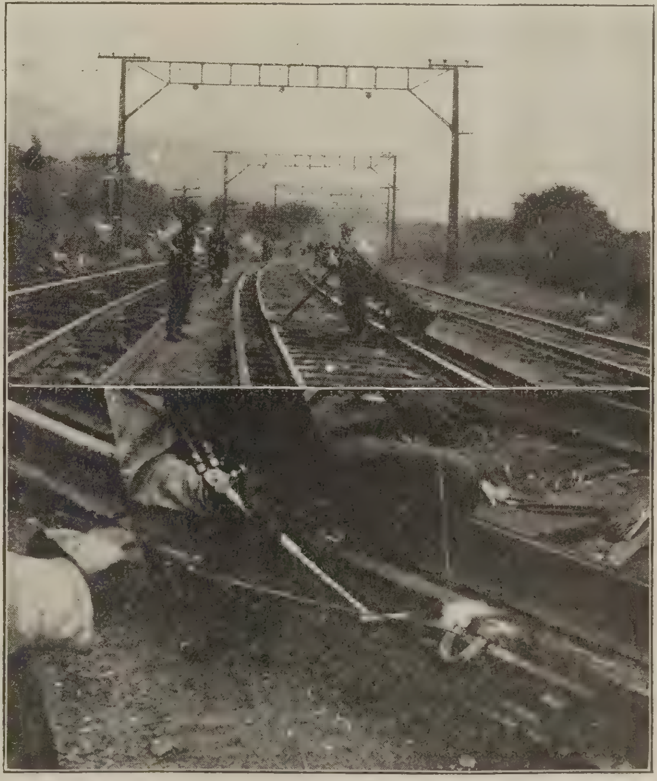
Under the desk is a 534-A desk set box wired to a receptacle on the observation car platform to which connection is made at important cities along the line which gives the passenger telephone service while the train is standing at these points.

The first of these cars to be completed left Chicago in charge of the Passenger Traffic Department on February 20, to make a trip through a large number of eastern cities at which time it was open to the general public for inspection.

Boston & Maine Installs Welded Bonds

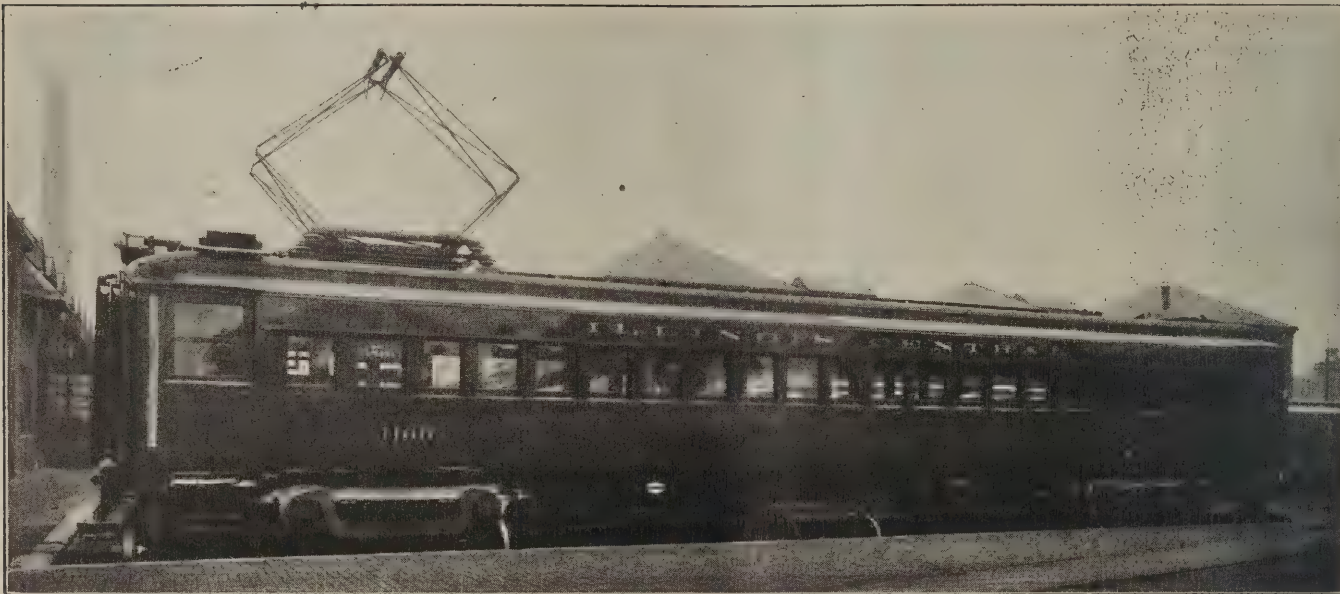
Gas weld bonds have been installed by the Boston & Maine on the electrified section which extends through the Hoosac tunnel, near North Adams, Mass. They are also being applied at other points for signal track currents.

A quality of new rail laid during the past season has



Gas Welded Bonds Being Applied to New Rails

been bonded with acetylene welded bonds and the operating department is well satisfied with the installation. The photographs were taken at the beginning of the work and show the new rail being bonded before it was thrown into gage. It is expected that all new rail on this property will be bonded with gas weld bonds including both the electrified zone and automatic signal territory.



One of the 1500-Volt Direct Current Motor Cars

Motor Cars and Trailers for Illinois Central*

Design, Operation and Maintenance of Equipment to be Used for Chicago Electrification

By W. M. Vandersluis

Electrical Engineer, Chicago Terminal Improvements, Illinois Central

THE initial tentative electric time-table for operation of electric trains on the electric lines of the Illinois Central in Chicago, provides for a total of 414 trains in a normal week day. Eighty-three of these trains will arrive and depart from Randolph street in the morning rush between 7:30 a. m. and 9.30 a. m. and 73 trains will arrive and depart from the same terminal between 4.30 p. m. and 6.15 p. m., the evening rush.

One condition to be met in the design of the electrical equipment required an appreciable saving in running time over steam operation. The average straight line acceleration rate is 1.5 m.p.h. per second, the braking rate 1.75 m.p.h. per second. Average voltage at the pantograph has been assumed at 1350, with a maximum of 1550 and a normal of 1500. Balancing speed on level tangent track at 1350 volts is 57 m.p.h. For speed determinations, wheel diameters are assumed as 36 in. average, 38 in. new and 34½ in. scrapping size.

Lengths of run between stops vary from 0.34 miles in local service to 14 miles in special service. The average runs between stops are 0.6 mile for locals, 0.95 mile for expresses and 1.7 miles for the specials. From an operating standpoint, it is necessary to have identical equipment for all services, so that motor equipment must stand the maximum service without injurious heating. The South Chicago local is the determining factor.

Orders have been placed for 130 motor cars and 85 trailers, which, with the 45 cars now in steam service, to be converted into trailer cars, will make available 130 two-car units for initial suburban service.

*Abstract of a paper read before the Western Society of Engineers in Chicago on March 9.

Mechanical Features

Motor car and trailer bodies are alike with the exception that the motor car underframe is designed for carrying the control equipment and the roof is designed for carrying two pantographs. Trap doors and steps, as provided for the original 45 cars, are omitted from the motor car and are installed only on the end of the trailer car adjacent to the motor car. As high platforms are being installed at all suburban stations, these trap doors and steps, one set per two-car unit, will be available for emergency use.

The cars are 72 ft. 7½ in. long over buffers, 10 ft. 6 in. wide over platforms at vestibule side door, and seat 84, 68 in cross seats and 16 in the four longitudinal end seats. Aisles are 3 ft. 0-½ in. between the seat backs.

The body of the car is steel, inside sheathing of pure aluminum, roof sheets and lower deck sheets of aluminum alloy; the doors, of which there are eleven per car, are made of sheet aluminum. Copper bearing steel is used for all steel in the car bodies.

The motor car trucks are equipped with two motors each and are of the swing bolster, equalized type with a wheel base of 8 ft. 3 in. The truck frames with pedestals, transoms and brake supporting lugs are integral steel castings. Wheels (new) are 38 in. in diameter of rolled steel. Clasp brakes are used on both motor and trailer trucks. Trailer car trucks are similar to the motor trucks, but with a wheel base of 6 ft. 3 in. and 33-in. wheels.

Collapsible safety gates are provided between cars to prevent possible accidents from passengers falling be-

tween them. For the convenience of the passengers, all cars are equipped with diaphragms to permit easy access from car to car without exposure to the weather.

Electrical Equipment

The motors have an hourly rating of 250 hp. and a continuous current carrying capacity of 210 amperes. They are 750-volt motors insulated for 1500 volts with two permanently in series on each truck.

Two pantographs are provided for each motor car, one over each truck center. Their supporting structure is provided with double insulation. The operating range is from 16 ft. to 24 ft. These are spring raised, air lowered, and all pantographs in a train may be controlled from any cab. Selector switches for the pantographs on each car are provided.

One control cab is provided for each car, located so as to be at each end of the two-car unit. A door encloses the equipment when the cab is not in use and allows full use of platform. This door forms a cab for the motorman when opened. The space in the body bulkhead opposite the control apparatus contains a folding seat for the motorman.

A 3½-kw. 1500 volt motor-generator set is installed on each motor car to supply energy at a nominal voltage of 32 for the control equipment, electro-pneumatic brakes, lighting circuits, door operating engines, train signals, door signal system, and for charging the battery which carries the low voltage load should the motor-generator set be inoperative.

This unit has a double commutator and has the generator enclosed in the same frame. It will run continuously with pantograph raised and the 300-ampere battery, carried for convenience, on the trailer car, will float on the line. A regulator of the carbon-pile type regulates the voltage and load taken by the set. Separate carbon-pile regulators control the lighting circuit voltage in each car.

The control equipment provides automatic acceleration by use of electro-pneumatically cam operated switch groups. Two independent electro-pneumatic line switches in series open the motor circuits and relieve the cam operated switches from opening circuits under load.

Automatic acceleration is obtained through current limit relays, but provision is made for positive manual operation step by step, if desired.

The control of the traction motors provides seven full field series control steps with five full field parallel and one normal field parallel step. Shunt or T-type transition from series to parallel is used. The master controller has a safety type handle, which will open the main circuit and set emergency brakes if released, except when the reverser handle is in the "off" position. It is also interlocked with brake apparatus so that power may not be applied unless the brakes are cut in service from the same cab.

Heating Apparatus

Heating is supplied at 1500 volts, with five car body circuits and one cab heater circuit per car. Car body units are of 750 watts each, with a total of 29 kw. per car. There are two coils per heater. Normally one element under each of the 34 cross seats and all under the longitudinal end seats may be energized. At low temperatures, or when needed to quickly heat the cars, the additional coil under each cross seat may be used. All circuits of heaters in the car body are controlled automatically by two thermostats of different temperature settings, subject to selection by trainmen on operating instructions.

The heating elements are of the enclosed type, the heater wire being embedded in an insulating compound having a high fusing point enclosed in a metal shell. Further protection is provided by the heater case designed to prevent the insertion of foreign objects.

Couplers

Each end of the motor car-trailer unit is equipped with an automatic mechanical, air and electric tight-lock coupler with a 6¼-in. x 8-in. friction spring draft gear and ball and socket anchorage. The draft gear is designed for a maximum curvature of 33 degrees. These couplers are self centering and units may be coupled or uncoupled by one man from any adjacent cab. They also may be operated by hand.

The automatic coupler contains the brake pipe and main reservoir balance pipe air lines and 39 contacts for the low voltage control circuits. The 1500 volt circuits are not bussed through the train. An interlocked switch to short circuit the door signal system on uncoupled ends of trains is included.

Couplers between cars of a unit are similar, but with a 1500 volt bus for heaters only, and must be hand controlled from under the car, as the motor and trailer cars will not be separated except in shops or for emergency purposes.

Brakes

Electro-pneumatic brakes will provide simultaneous application on all cars of a train. This brake equipment functions pneumatically at the same time as it functions electrically, so that if the control voltage fails, the brakes will operate as standard automatic air brakes, without requiring any additional attention by the motorman.

Service braking is at the rate of 1.75 m.p.h. per second and emergency braking at not less than 3.00 m.p.h. per second. Normal brake pipe pressure is 90 lb. A 1500 volt d.c. motor driven air compressor having a piston displacement of 35 cu. ft. per minute, with two 16-in. x 60-in. main reservoirs, is installed on each motor car. Governors operate from 100 to 115 lb. per sq. in. and all compressors in a train start when any governor cuts in, through a synchronizing train line circuit operating at control voltage.

Door Controls

The four vestibule side doors are operated by 32-volt motor-operated door engines.

Control stations are provided just outside of car end doors, containing a master switch which controls all four doors on one side of the two-car unit and a switch for the individual door adjacent to the station. The four doors can be controlled from any one of the four controls switches. Duplicate switches are provided on the opposite side for similar operation of the four doors on the opposite side of the unit. In addition, when the motorman's cab is in use, the control of his outside door is automatically taken away for the other switches and he can control this door from a separate switch in the cab.

Watt-hour meters are installed in the motor circuits of each car with remotely operated dials in each cab. These meters have inspection dial to permit shopping on the kilowatt-hour basis if desired.

Electrically operated window wipers are used for each motorman's front window.

Aluminum alloy conduit, outlet boxes and wiring devices are used whenever thought practicable with a view to further reducing the car weight.

The motor car without passenger load weighs, completely equipped, 141,000 lb., and the trailer car 85,000 lb.

Inspection and Repair Facilities

In addition to the inspection of the multiple unit equipment at terminal points to take care of minor repairs and emergency adjustments, it is planned to have inspections made after every 1,500 miles of run. As the daily mileage per unit is about 100, facilities are being provided for light inspection of all cars at least twice a month, initially.

A study of the time necessary for the light inspection shows that this may be done in about 4½ hours or during the day layover at Randolph street between peak hours.

To take care of this work a light inspection building 76 feet by 480 feet, 28 feet high, is being built in the space nearest to Randolph street which is available, which is at 16th street. This building will have four tracks with a capacity of six cars each. Concrete inspection pits are being installed for all tracks. Runways adjacent to top of cars will facilitate pantograph inspection and tests.

Equipment consists of an air compressor for blowing out electrical apparatus, portable car jacks, electric lift truck, relay testing devices and portable transformer outfit for high voltage tests, as well as miscellaneous small tools. A storeroom for small repair parts and complete oil storage facilities are included.

Heavy inspection of multiple unit cars is considered advisable every 6,000 miles, or every fourth light inspection. The time required is estimated at 16 hours for each motor car-trailer unit. The cars must be sent to a shop and all apparatus covers removed so that detailed inspection can be made and the apparatus cleaned, oiled and blown out with air to remove metallic dust and other dirt accumulations.

A complete overhaul is planned after every 35,000 miles of service, or one a year. At that time heavy mechanical repairs can be made to car bodies and trucks and cars painted or varnished as necessary. The time required in the shop is estimated at about three weeks.

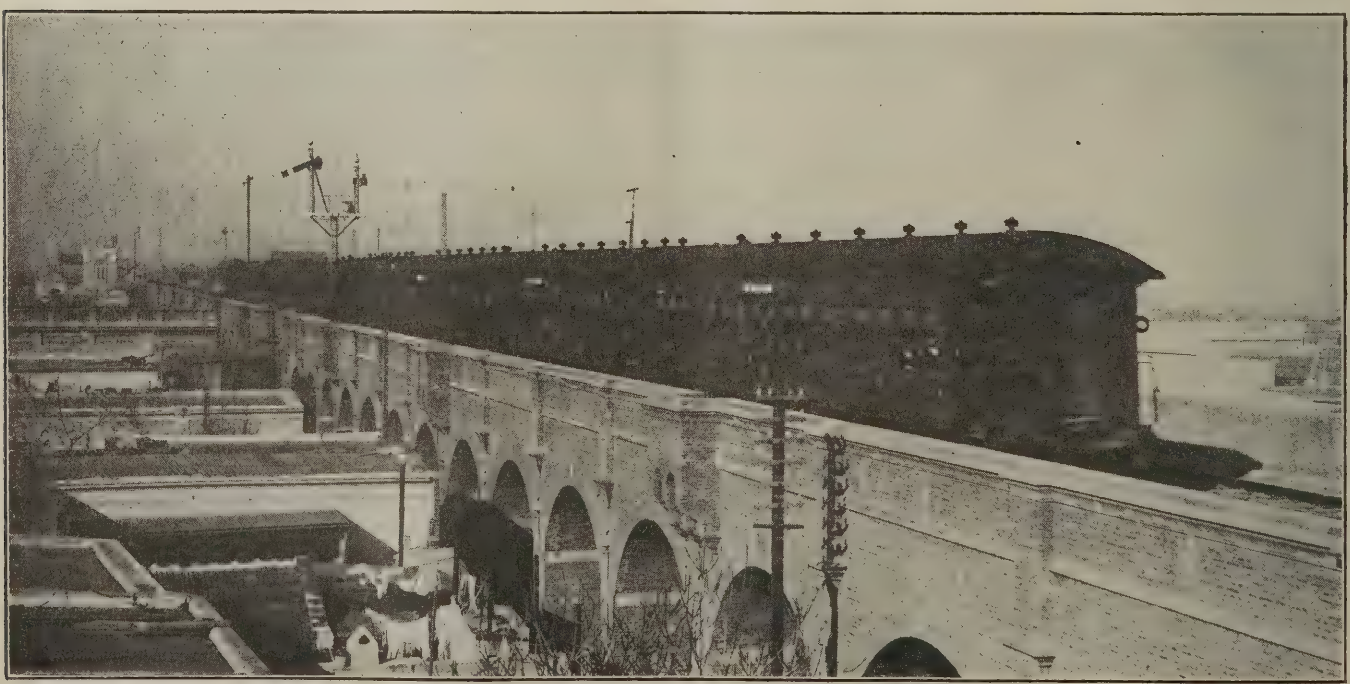
For the heavy inspection and overhaul work, an electric shop is being built at the main shops of the system at Burnside, near 95th street. This is designed as a permanent building and fits in with the general scheme cf extension of the present passenger car facilities. It consists of a heavy inspection shop 86 ft. by 350 ft., 29 ft. high, with four tracks, each to handle four cars. Concrete pits are laid out under each track and the whole shop is served with two 25-ton traveling cranes with main and auxiliary hoists.

Adjacent, with a common partition, is a repair shop for electrical equipment only, 70 ft. by 350 ft., served with a ten-ton traveling crane. A testing room will be located in one end of the repair shop.

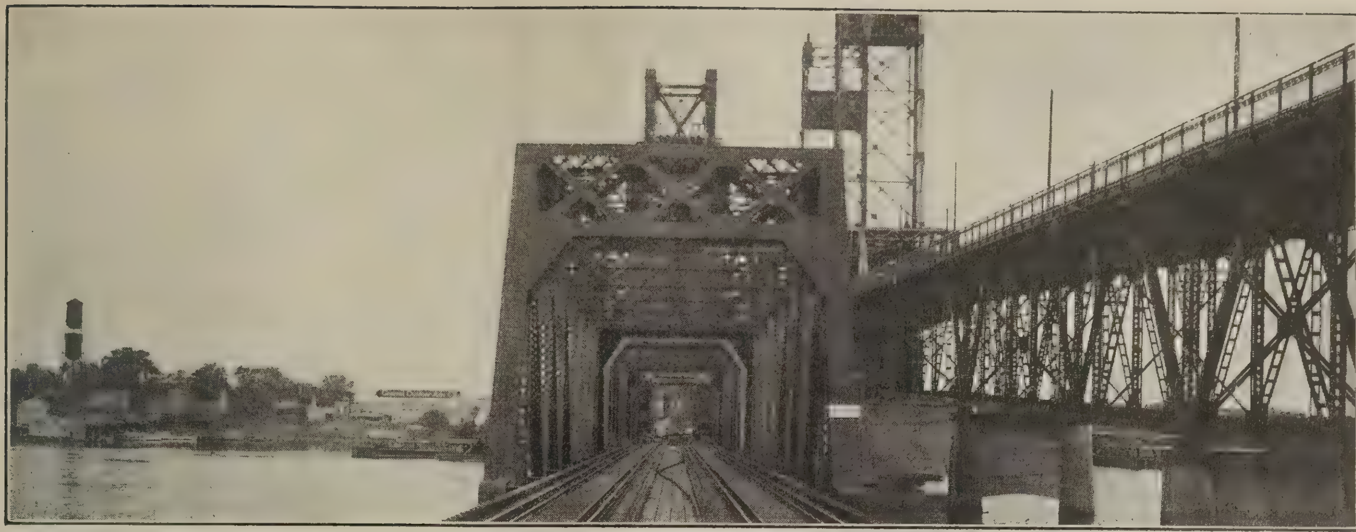
The shop equipment will consist of the necessary tools and fixtures for repairs to motors, control equipment, air compressors and all accessories including storage battery charging. Electrified yard tracks for storage and testing are being built in connection with this repair shop.

It is the intention to use the heavy inspection building as a stripping and assembling shop for the cars, which, after removal of the electrical equipment, will be sent to the regular shop, near by, for necessary complete overhauling or repairs, returning to this shop for mounting of the electrical equipment when overhauling has been completed.

At a later date, it is the intention to build a stripping and assembling shop, truck shop and wheel shop in connection with these new buildings.



Buenos Aires Southern Viaduct, Entrance to Buenos Aires



Electrically Operated Bascule Bridge Over St. Johns River at Jacksonville, Fla.

Florida East Coast Bridge Over St. Johns River

Electrical Energy Meets Every Requirement for Power, Indication and Safety in Huge Bascule Bridge at Jacksonville

A NOTABLE application of electric power is seen in the single leaf Strauss Trunnion Bascule bridge on the Florida East Coast over the St. Johns River at Jacksonville, Florida. This huge bridge which has a lift span of 216 ft. and weighs 650 tons, was placed in service in the latter part of November, 1925. The river traffic is such that it is necessary to raise the bridge between 20 and 30 times a day and every facility has been provided to make a failure of the bridge to open practically impossible.

The principal source of power for bridge operation is derived from the city of Jacksonville and electrical energy is furnished to a substation located on the north end of the bridge at 13,000 volts, three phase, 60 cycles. This power is stepped down to 440 volts at which voltage it is used for the operation of the main motors.

At the transformer substation is located a steel cabinet which houses an automatic oil switch actuated by a timing device. If for any reason a short circuit occurs in the wiring or in any of the electrical equipment on the bridge, the main circuit breaker will be thrown open. At the end of 15 seconds, the time reset feature of the switch functions and the circuit breaker will be closed. If the breaker is again thrown open due to the persistence of the short circuit it will again be closed at the end of 30 seconds. This operation is repeated a third time at the end of 45 seconds, but if at the end of this time the circuit breaker will not stay in, the trouble must be located and removed before the breaker can be closed, which is then done by hand.

Auxiliary Power

As a failure of power is a contingency which may arise at any time, necessary provisions have been made for the operation of the bridge in such an emergency. On the lower floor of the operating building is located equipment which is used in the event of power failure at the substation. This emergency outfit consists of a Sterling Dolphin gasoline engine manufactured by the Sterling Engine Company of Buffalo, N. Y. This engine, which is rated at 158 hp. and runs at a speed of 1550 r.p.m., is direct connected to a General Electric type EP generator with normal operating speed of 1200 r.p.m. Should it become necessary to operate the bridge from this equipment, the time required to change over from the city power, start the gas engine and raise the bridge is approximately 8 minutes.

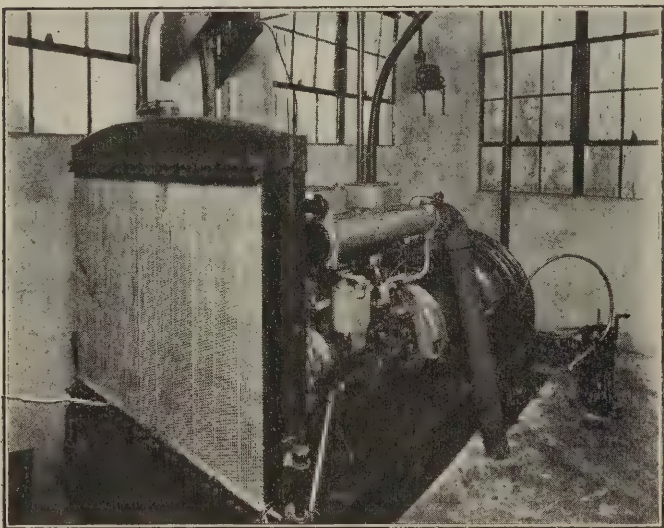
Machinery Room

The machinery room is located near the upper part of the bridge and in addition to two large main motors and connecting gears, also houses a switchboard which carries the necessary controlling equipment for the operation of the motors. The main motors are of the Westinghouse induction type. These have a rating of 225 hp. each, 440 volts, 3 phase, 60 cycles and run at a speed of 312 r.p.m., taking a full load current at 490 amperes. A smaller auxiliary 50 hp. Westinghouse induction motor which is also three phase, 60 cycle, is used in connection with the auxiliary gas engine generator set previously mentioned. This motor is arranged to drive a large gear which in turn rotates a small pinion that meshes with the main train of gears used in raising or lowering the bridge. The gearing of this motor is normally held away from the main gear train by means of a lever which is secured by a bolt in a supporting saddle. When the occasion arises it is a simple matter to remove this bolt and throw the lever to the right so that the small motor may be used to raise or lower the bridge.

The switchboard in the machinery room carries a large three pole, double throw switch on its center panel. When this switch is thrown upward the power supply at 440 volts a.c. is fed to the main motors from the controller located in the operating room. When the switch

is thrown downward, connection is made to the auxiliary motor.

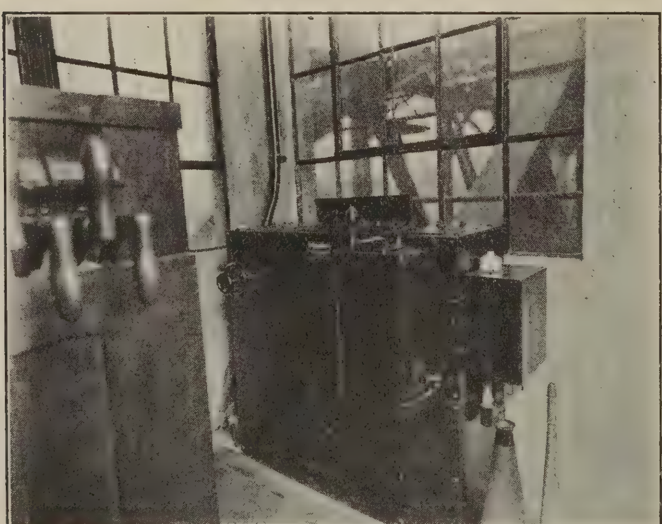
The first panel of the switchboard in the machinery room carries a three-pole Westinghouse main motor switch and a number of Westinghouse type F magnetic contactors. On the second panel is mounted the main



Emergency Gas-Electric Auxiliary Equipment Which Operates Bridge in Case of Power Failure

motor brake fuse and also small contactors for the operation of the auxiliary motor. All of these contactors are operated from the controller downstairs in the operator's room. The relays at the top of the panel are brake relays used in connection with the brake drum on the shafts of the motors.

On the right of the main switch in the center panel is mounted the apparatus used in connection with the auxiliary motor. This equipment is practically the same as



Corner of Operating Room Showing Controller for Raising and Lowering Bridge—Signal Interlocking Machine at Left

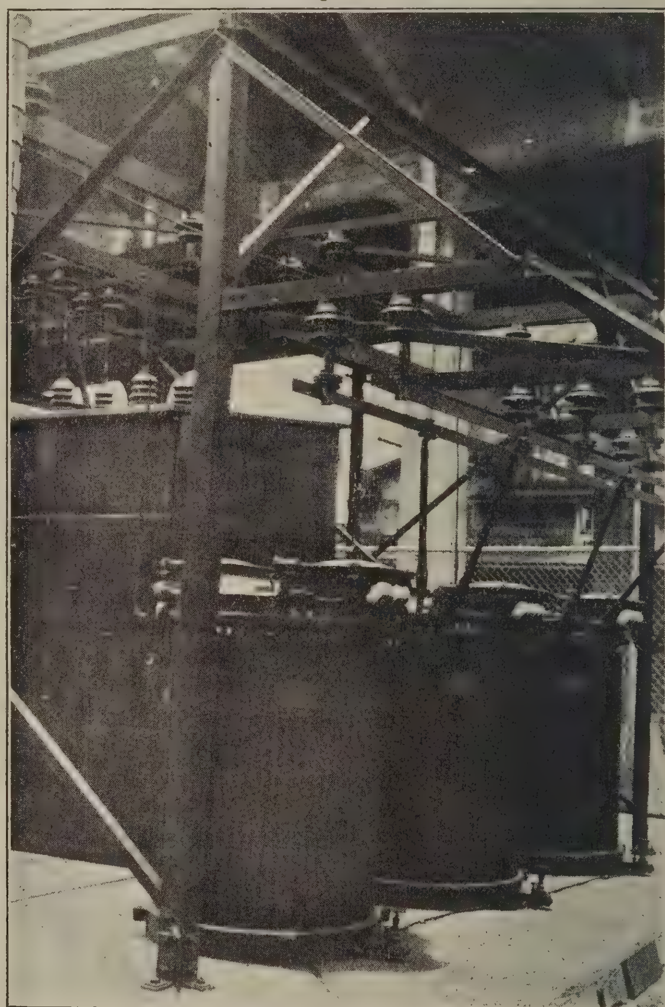
the other but it is somewhat smaller, being of smaller capacity.

The last three panels carry apparatus for the operation of the second large bridge motor and this apparatus is an exact duplicate of that mounted to the left of the center switch.

In bringing the motors up to full speed, resistance units are cut out by the contactors mentioned. These resistance units are mounted above and in the rear of the switchboard on angle iron frames and the wires leading to them are plainly visible in the photograph.

Operating Room

In the operating room downstairs there is also considerable equipment. A somewhat smaller switchboard carries large fuses on the left end panel at the top. Just below these is located a large three-pole, double-throw knife switch. When this knife switch is thrown to the right, current is supplied to the main motors from the

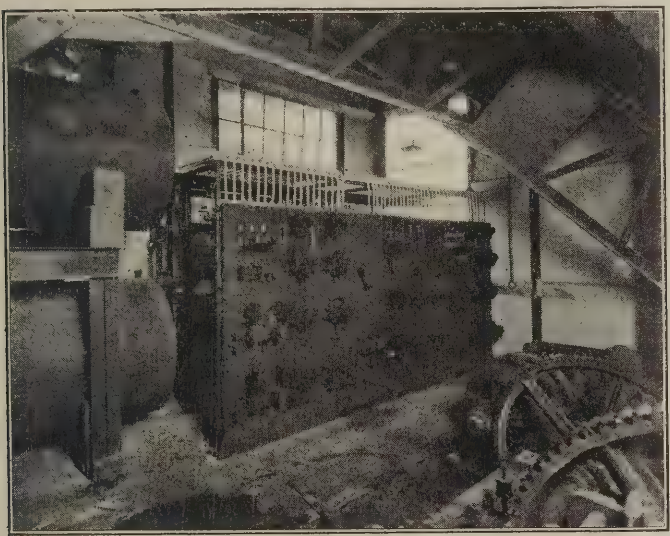


Outdoor Substation at North Approach to Bridge—Energy Is Received at 13,000 Volts and Stepped Down to 440 Volts

commercial source, and when thrown to the left, this switch connects to the auxiliary power plant in the room below. On the lower part of this same panel is installed an oil circuit breaker. It is to this panel that the power is fed from the transformer substation and from this panel to the main motor switch in the machinery room above.

On the next panel is mounted a three-pole, single-throw knife switch for controlling the lights and heating equipment. The installation of the heating service has not been completed yet, but when eventually installed will consist of two 220-volt heating units connected in series, and current at 440 volts will be supplied with this combination. The second panel also contains two small control switches which are in the circuit controlling the

lock motors at the end of the bridge. On this board are located fuses which protect the circuits for machinery room lights, house lights, stairway lights, navigation lights, indication lights and for battery charging. In connection with the lighting system it may be noted that a one kw. transformer has been provided for emergency lighting. If the city power is interrupted this transformer is connected to the auxiliary power supply.



Switchboard in Machinery Room with Bank of Resistances in Rear of Board

The auxiliary generator field and exciter field, generator starting and engine ignition as well as gas and spark control are all handled from the operating room. At the position where the operator must stand in order to raise or lower the bridge, there is a series of indication lights which tell when the lock is set or open, when the bridge is fully closed or fully open and when it is nearly closed or nearly open.

General View of Machinery Room Showing Gear Train and Driving Motors

Provision is made at the lock motor for operating the lock by hand cranking in the event of power failure.

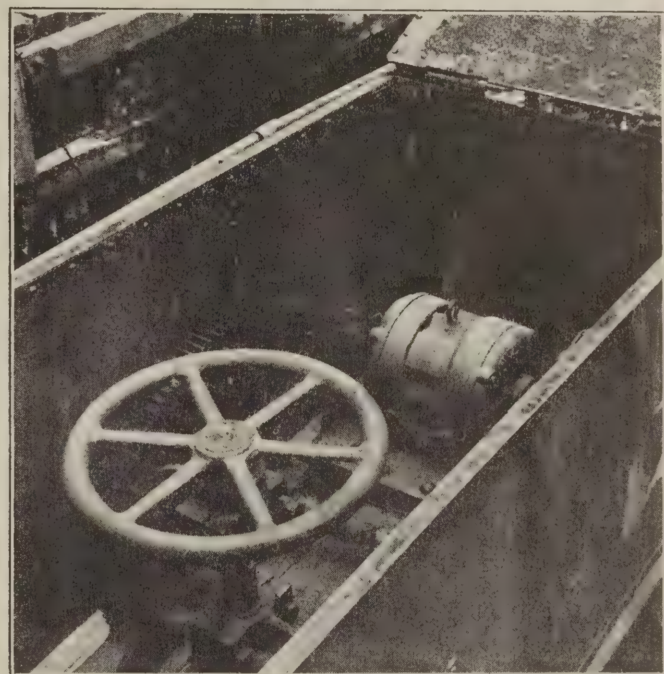
Control Circuits

Power is brought from the resetting device at the transformer substation by submarine cable to the three-pole, double-throw knife switch in the operating room and thence through the oil circuit breaker, to the double-throw, three-pole knife switch in the machinery room where it passes through the contactors to the motors.

On the switchboard in the operating room there is mounted a clip which is in contact with one of the knife blades of the large three-pole double throw switch. This clip makes connection with all of the control circuits and when the three-pole switch is thrown to the right it becomes impossible to operate the large motors on the auxiliary power.

From the three-pole switch in the operator's room, the master controller circuit goes through the emergency brake relays and out to the limit switch mounted on the end near the locking motor and back to the master controller which makes it impossible to attempt to raise the bridge until it has been unlocked.

From the limit switch at the end of the bridge, the current goes through a small interlocking machine in the operating room and then to the master controller and from here to the magnetic contactors on the switchboard in the machinery room.



Bridge Locking Motor in Housing at North End of Bridge

Operating the Bridge

When the bridge is to be raised, current is supplied through the contacts on levers 7 and 8 which are the master levers in the interlocking machine, and when these are pulled out they allow current to pass to levers 5 and 6 which control the smash boards. When levers 5 and 6 are pulled out the smash boards are lowered. Levers 1, 2, 3 and 4 control the signals which permit the trains to pass over the bridge The particular lever pulled depends upon the direction of traffic.

When a train passes onto the bridge, a light indication is received and the signal lever must be put back into the normal position. If this is not done and a second train follows before the machine is restored to the normal position, the lever will be electrically locked in its pulled-out position and in order to restore it to nor-

mal so that a signal for the second train may be given, it will be necessary to operate a time release which requires two minutes before the lever can be restored and the signal cleared.

All signal levers must be in their normal position in order to open the bridge and when these levers are in this position the control circuit for the bridge mechanism is energized. The emergency brake is first released, the locking motor unlocked and the current is then brought to the master controller which controls the upward movement of the bridge. As the bridge reaches a vertical position, the limit switch cuts out. Indication lights, which show the position of the locking motor at all times, are located on the master controller panel immediately in front of the operator.

In lowering the bridge the motors are simply run in the reverse direction. When the bridge is about 5 ft. from landing the limit switch kicks out and it is necessary for the operator to hold down the limit switch contact button, which is conveniently located, with his left hand and operate the controller with his right in order to land the bridge.

In order that the bridge may set easily, and without jar, it is equipped with two air cylinder bumpers controlled by valves. The locking motor is again operated and the bridge is ready to handle railroad traffic.

Brush Shunts*

The brush shunt—formerly termed the pigtail—is, as its names implies, used to carry the current from the brush around the intervening parts to the brush stud or in the opposite direction from the stud to the brush.

The object of using brush shunts is to prevent burning of the holders; relieve the brush spring of carrying the current and make a flexible connection to the brush. If the current is conducted from or to the brush through the holder there is always more or less arcing between the sides of the brush and the holder which causes heating, burning of the holder and side wear on the brush. When the brush springs are allowed to conduct the current from or to the brushes they become heated, losing their tension in varying degrees and give unequal brush pressure. Also the current passing between the brush and the spring causes the brush to wear on the top, due to burning—this being one form of hammer wear. A flexible connection to the brush allows it to ride freely over the commutator following the surface closely at all times, thereby constantly giving a firm, steady contact.

A good brush shunt should be mechanically strong, have good electrical contact with the brush and be able to stand up under continuous heavy duty in service. The shunt must be strong to withstand handling previous to and in its installation as well as the pounding of the brush due to chattering or severe service. It is very desirable to have the contact drop from the brush to the shunt low in order to prevent overheating resulting in deterioration of the connection. The shunt must give perfect service throughout the life of the brush and should be as perfect at the end as when it was first installed.

In the design of all shunts the following points must be taken into consideration: the selection of the cable, the attachment of suitable terminals and the desirability of insulation.

Cable of sufficient size to carry more current than the maximum capacity of the brush should always be chosen, as all steps possible should be taken to aid the brush to give perfect commutation. The cable must be flexible in order to allow a free movement of the brush as well as a ready and practical attachment to the machine. This flexibility may be obtained by the use of small wires in the cable or the use of two smaller cables in the shunt in place of one large cable.

In general there are three types of terminals: the slotted, the hole and the plug and whereas these may take any number of forms the types are always readily distinguishable. The slotted terminal has a "U" shaped opening which slides under the head of the binding screw with the minimum amount of trouble and is easily attached or detached while the machine is in operation. The use of the hole terminal requires that the binding screw be entirely removed from the machine in order to attach it, but when once attached it cannot loosen and drop into the machine without the screw coming entirely out again.

It is not often that after the binding screw is secured on the terminal that it loosens sufficiently to cause trouble so that the advantage of the hole terminal over the slotted type in this respect is questionable. When removing the screws for attaching the hole terminal they are frequently lost or dropped into the machine as they are often in difficult positions; this is a decided disadvantage. The plug terminal slides or is screwed into a hole designed for it on the machine and is usually fastened by a set screw being turned against it. This type is really special and should be avoided where possible.

Insulation of brush shunts is used in general to protect against grounds or short circuits where the clearances are very small, which is the case on some types of machines. This insulation is of two kinds, lava or glass beads and cotton or asbestos sleeving. For high voltages the beads are to be preferred while with low voltages the sleeving is very satisfactory. If the machines are enclosed or the temperatures high the asbestos sleeving is often found necessary to insure the insulating value of the sleeving.

Protection against acid or other injurious fumes also is often desirable. This is obtained by the use of tinned cable—each wire of the cable being tinned separately—which is found to be a reliable means of protecting the copper leads.

Brush shunts are designated in different types according to the manner of their attachment. These we will divide for the purpose of description as follows: 1st, soldered; 2nd, riveted; 3rd, cemented; 4th, bolted; 5th, with lifting clips; 6th, with special plates or lugs; 7th, miscellaneous types.

The *soldered* is an early type which has been used quite extensively due to its simplicity and ease of application. This type is weak mechanically for with overheating the solder has a tendency to flow, allowing the cable to loosen from the brush. In later years the soldered type has been superseded to a large extent by the riveted and cemented types which are entirely reliable.

The *riveted* type is a very satisfactory shunt. Its adaptability to practically all kinds of brushes with its uniformly good service make it one very popular with operators. The special riveting process gives this con-

* From a Bulletin Published by the National Carbon Co.

nection great mechanical strength and very perfect electrical contact between the cable and the brush which fulfill all the demands of an exacting service.

The *cemented* type connections as shown in the above catalogue under the numbers 9D and 15 and another type designated as 15A—which is the same as the No. 15 with a hammer clip similar to the No. 6A—are equally as satisfactory as the No. 6 series described above. This shunt is attached to the brush by means of a special conducting cement which is tamped around the cable in a hole in the brush prepared for attachment. This cement sets firmly, giving an extra strong mechanical and electrical connection which is adaptable to practically all sizes of brushes at low cost and at the same time allows the maximum wear on the brush.

The *bolted* type shunts are used where a detachable shunt is desired. The loosening of these bolts in operation and the failure of the connection in consequence is the weakest feature of this style. In the past this type attained considerable popularity on account of the high cost of other types, but has at the present time almost gone out of use on account of the lower cost of reliable types and dissatisfaction and poor service to which this type is always liable.

Lifting-clip types of shunts are special and are used only on machines which start with the brushes free from the commutator. Standard styles of this type have worked out satisfactorily in service. These lifting clips are designed to meet the requirements of the lifting apparatus of standard machines.

Special lugs and plates have been designed by some motor and generator manufacturers for attachment to brushes to be used on their machines. In general these should be avoided wherever possible on account of the difficulty in obtaining replacements and the high cost of preparing the brushes for, and machining of, these special plates, lugs, straps and saddles. There is a tendency at the present time for machine manufacturers to use none but standard connections for their brushes. Special parts of the nature described above should be considered as part of the machine.

There are numerous miscellaneous types of brush shunts on the market in almost innumerable numbers, mostly makeshift in character, which are adaptable to limited application. In all cases it is recommended that a shunt as near standard as possible be used.

Troubles with brush shunts are sometimes encountered as with all parts of moving machinery, but in most cases these are readily located. In the first place, reliable brush manufacturers take a great deal of care in the selection of the proper brush shunt, in the proper design of this shunt as applied to the particular brush on order, and in the manufacture of these shunts to see that they leave the factory in perfect condition. If the shunt is not designed with sufficient current capacity to carry the applied load it will overheat and eventually break down; this in turn, will cause a heavier load on the remaining cables which will fail; the remedy is to use larger cable. Selective commutation is frequently encountered where cables of under capacity are used, due to the shifting of the load caused by the cables overheating. When a shunt or several shunts loosen on a machine the high resistance of these connections also cause the load to shift to the other brushes. Brush holder springs sometimes vibrate against the shunt, cutting it off, or again the connection jars loose, due to vibration of the brush, caused by a rough or untrue commutator, the brush being loose in the holder, or high friction. Any of the above troubles will cause the load to shift to the remaining good brushes and may result in selective commutation. If soldered shunts become overheated the solder will often flow in between the brush and the holder, welding it in place, causing it to arc and burn.

In conclusion, standard shunts should be used wherever possible; brushes and shunts bought from reliable sources whose shunt design and manufacture can be depended upon to be correct; and inspections of machines made periodically to correct slight faults of operation which invariably increase the trouble if allowed to exist.

D. L. & W. Three-Cylinder Mountain Type Locomotive at Paterson, N. J.

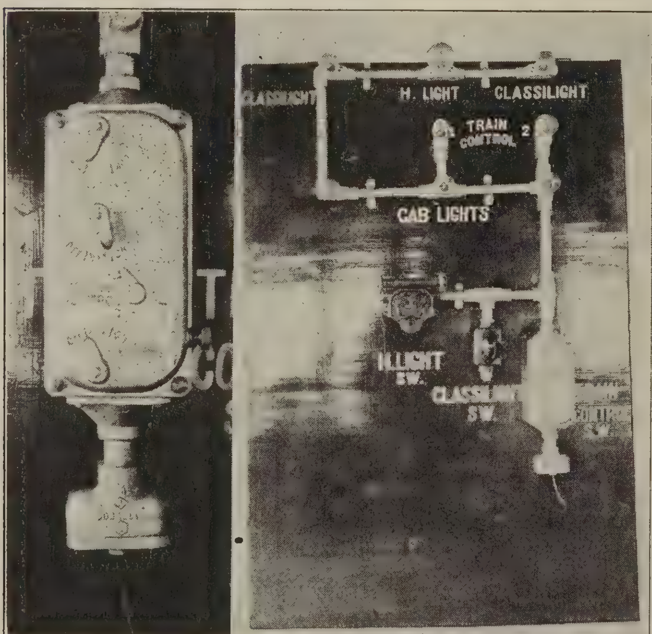
Train Control Instruction and Inspection

Two Important Factors in the Maintenance Program of the Richmond, Fredericksburg & Potomac

THE difficulties of train control operation arise from two sources. One is the trouble that is involved in getting the right sort of co-operation of the enginemen and the second is the natural troubles which may be inherent in any particular type of train control.

The Richmond, Fredericksburg & Potomac has arranged a simple structure of condulet fittings to simulate the lighting on a locomotive. This device is mounted upon a large board and the various parts are plainly marked so as to make it an ideal means of imparting information to the engineman in a class room.

The type of train control which the R. F. & P. have been experimenting with is the Union Switch & Signal Company's continuous indication. The locomotive is equipped with two Sunbeam headlight generators. The part of the train control equipment of which the engineman must have knowledge consists principally of what is known as a double transfer switch, and, it is concerning this switch that most of the instruction is given. Although the switch is not particularly complicated there are a num-



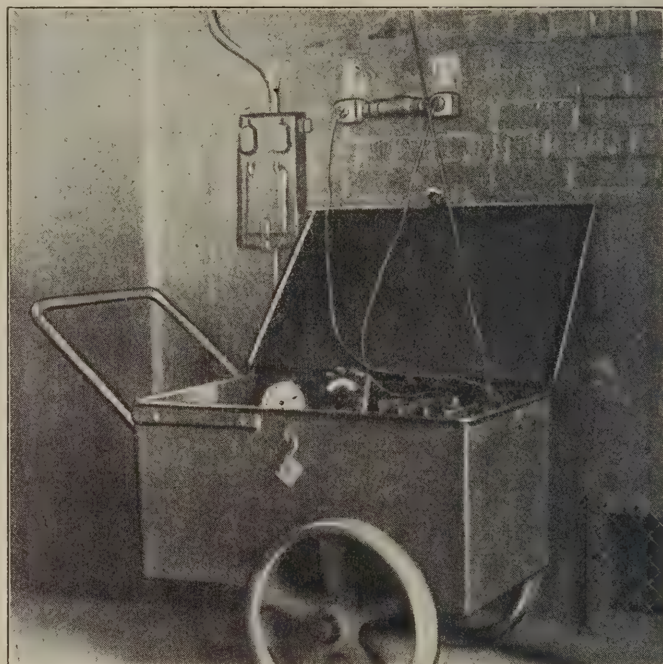
Right: Enlarged View of Double Transfer Switch. Left: Instruction Board Upon Which Are Mounted Conduit Fittings and Lamps to Correspond With the Lighting and Train Control Equipment on the Locomotive

ber of operations involved in its use which seem to confuse them.

The Double Transfer Switch

When compound generators are used this switch is necessary to prevent the train control load from being thrown on to a generator which is not running. When the power is disconnected from the train control terminals the dynamotor which is used for furnishing the high plate voltage will run for several seconds and generate a back e. m. f. If the train control load is thrown on to a generator not running this back e. m. f. forces a current in the reverse direction through the series field of the generator, reversing the residual magnetism. Then when the generator is started it will build up with reversed polarity.

With this double transfer or interlocked switch it is necessary for the engineman to operate the interlock when transferring train control from one generator to the other. The time consumed in operating the interlock is sufficient



Portable Equipment Used By Roundhouse Maintainers For Testing Train Control Apparatus on the Locomotive

to insure that the train control dynamotor has stopped before the train control load is connected to the second generator.

The interlock consists of a disk operated by a worm and gear. The disk is slotted at one point so that only one switch at a time can be placed in the "on" position. In order to place the second switch in the "on" position it is necessary to move the disk by the worm and gear until the slot is in such a position that the second switch can be moved. Before the disk can be rotated to this position, however, the first switch must be placed in the "off" position.

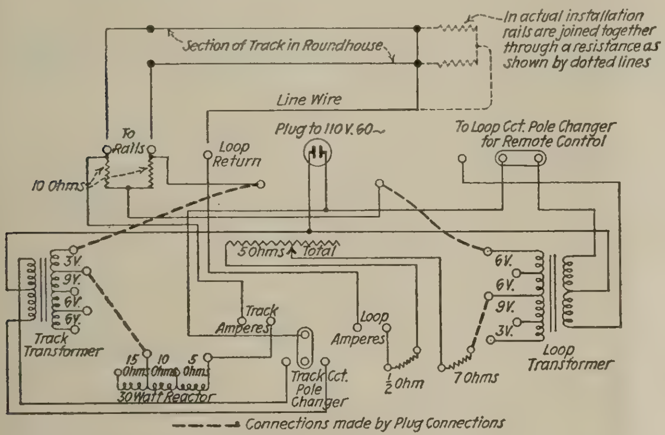
In ordinary operation one of the headlight turbines is used for the engine lighting and the other for train control, and the switch which has just been described is used only in event of the failure of one of the turbines.

Inspection of Equipment

The inspection of the train control equipment is made at the roundhouse where a number of tracks have been fitted up especially for this purpose. A portable testing set mounted on wheels is used by the roundhouse maintainers in checking up the operation of the train control

circuits on the locomotive. A diagram of the equipment in the testing outfit is given in one of the illustrations.

At the head of each track equipped for testing purpose are three receptacles mounted upon the wall. One of these is marked "T" and the conduit upon which it is mounted carries two wires to the ends of the rails nearest to it. A second receptacle is marked "L" and this carries a single wire which goes to the rear of the locomotive and connects the two rails together. Ordinarily the two rails are connected through a resistance and the "L" or loop return wire as it is termed is connected to a point at the electrical center of this resistance. The resistance is necessary on the road to prevent the shunting out of the track relays. The third receptacle is used to supply 110 volts a. c. to the testing set.



Wiring Diagram for Automotic Train Control Portable Test Set

Testing Procedure

Referring to the sketch the two terminals marked "to rails" are connected to the rails in front of engine. This is through the "T" receptacle previously mentioned. The connection marked "to loop return" goes to the two rails tied together behind the engine and has also been explained.

A track circuit is set up by plugging from track transformer to terminal "D" and to adjustable taps on 30-ohm reactor. The value of the track current is measured on an ammeter plugged at a point marked "track amperes." The value of the track current can be set by changing the taps on transformer and reactor.

The polarity of the track circuit can be reversed by a single pole double throw switch located in the center of the set.

A pole changer is necessary on a three indication system in order to obtain medium speed indication as with medium speed indication set up, the track current flows in the opposite direction from that of a high speed set up.

A loop circuit is set up by plugging from the loop transformer to the terminal "C" and to adjustable reactors. Loop current is measured on an ammeter plugged in at point marked "loop amperes." As with the track circuit the value of the loop current can be adjusted with the transformer and resistance taps and for finer adjustment a slide resistor is included in the circuit.

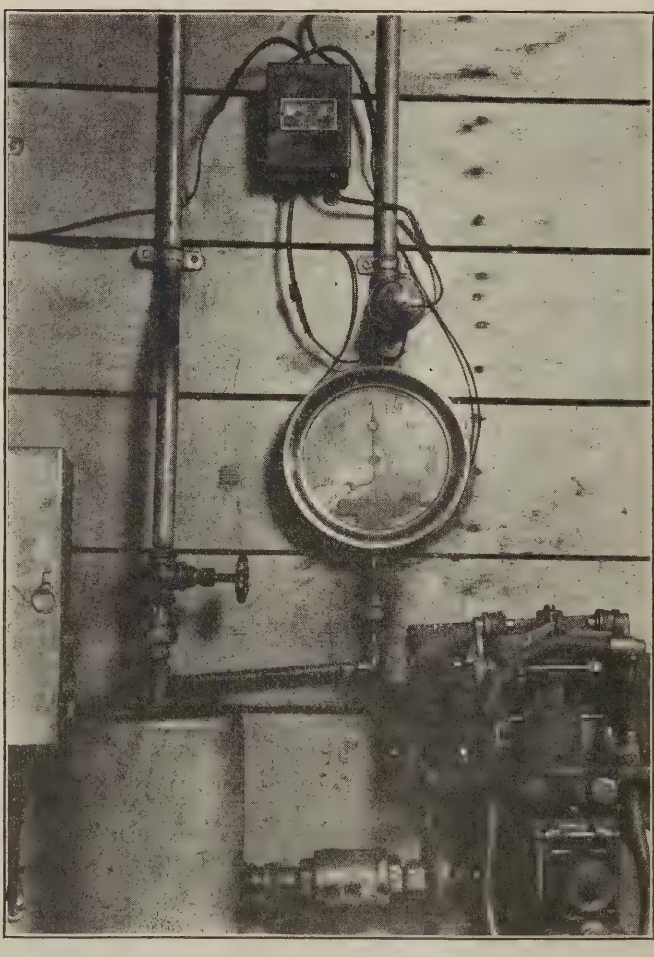
For test purposes the track circuit is set at 1½ amperes and the loop circuit at about 0.5 ampere. The loop circuit pole changer is used with the three indication system to reverse the polarity of the circuits from a remote point such as an engine cab. To use this the jumper shown in the sketch is disconnected and a three conductor cable is run from the three terminals to a single pole double throw switch located at the point from which it is desired to control the set. The polarity of the loop circuit can then be reversed by a single pole double throw switch in the same manner as the track circuit polarity is reversed by a pole changer.

It has been found by experience that it is better to check up the equipment on the locomotive when it arrives than to do the testing just prior to a departure.

Plaza Constitucion Station, Buenos Aires

Low Pressure Alarm

A novel form of low pressure alarm for the yard air line is used on the Northern Pacific at Seattle, Wash. The air line is supplied by a Westinghouse automatic motor driven air compressor. A pressure regulator shown in the lower right-hand corner of the illustration starts and stops the air compressor automatically and keeps the air pressure within predetermined limits.



The Alarm Contact Is Made Between the Gage Needle and Mercury in a Grooved Fibre Block

A low pressure alarm was wanted which would sound if the pressure should go below 80 lb. and an electric bell and a bell ringing transformer were procured for this purpose. The bell was mounted on the wall in an adjoining boiler room, where there is a man on duty at all hours. The transformer was mounted on the wall in the compressor room just above the pressure gage and the primary of the transformer connected to the lighting supply circuit. The secondary was connected to the bell with one side of the circuit running through a contact in the pressure gage.

To provide the alarm contact, the face of the pressure gage was removed and a fibre block, as shown, screwed to the dial. The upper edge of this block is grooved or cupped and the groove is filled with mercury. The lower end of the gage pointer was bent so that it dips into the mercury when the pressure falls to 80 lb.

One lead from the secondary of the bell ringing transformer is connected to a screw in the fibre block. This screw is in contact with the mercury. One lead from the bell is connected to the case of the gage. When the pressure falls to 80 lb. the lower end of the needle makes contract with the mercury and the bell rings. The groove in the fibre block is so shaped that the needle can pass clear through the mercury cup and out of the other side. This avoids bending of the needle in case the pressure should continue to fall below 80.

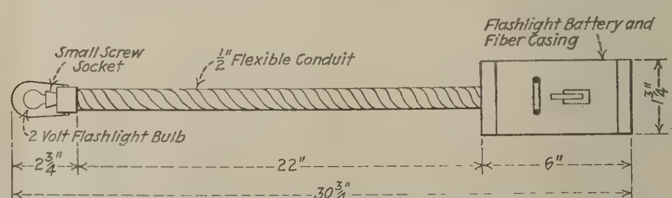
This device was designed and built by B. A. Hendricks, electrical foreman.

Handy Lamp for Small Openings

By W. W. Miller

Electrician, Norfolk Southern Railroad, New Bern, N. C.

Some time ago, the boiler maker came to me and asked me if I could make him a small lamp that would go into a 2 in. wash-out plug in the boiler. After giving the matter a little consideration, I made the outfit shown in the



This Handy Lamp May Be Readily Assembled From Materials Easily Obtainable

illustration and turned it over to him. Later he reported that it was quite satisfactory.

Such a lamp can be placed in many places where it is practically impossible to get a larger lamp. It is very simply made; the number of parts consist of an old flashlight fiber casing, a piece of ½ in. flexible conduit. a small screw socket, a 2-volt flashlight bulb and the battery. The sketch shows the general arrangement of the parts.

Probably Both

Our stage and daily papers
  Are full of strenuous capers
With this dance they call "The Charleston"
  (Which St. Vitus did invent).
All our Shebas and their misters,
Their cousins, aunts and sisters,
Bung their feet all up with blisters
  In each contest and event.

But as near as I can figger,
There's a dance a whole lot bigger;
It lasts a durn sight longer
  (And we all participate).
'Tis a perpetual syncopation
That knock-knees our cock-eyed nation
And which without equivocation
  Catches all who navigate.

For a partner, Fate has given
Us "High Cost of Livin'"
She is some eccentric spinster
  (Who struts about the floor).
In the dark we want to croak her;
In the light we'd like to choke her,
Or in both optics poke her—
For *our* "dogs" are getting sore.

She cares not how much we're making,
Or how bad our shanks are aching:
She demands we keep on dancing
  (Though our shoes are full of gore).
If we get some dimes and nickels,
Through our fingers then it trickles,
For shoes and booze and pickles,
  And she whispers "get some more."

You can scan romantic pages,
On the vamps of all the ages,
And some of them were Dicky-Birds
  (If all we read is true).
But their work which we think shady
Was above board and parady
When compared to this wild lady
  Who is wished on me and you.

The butchers and the bakers,
Radio and flivver makers
In the jazz-band now are sitting
  (With an ever-watchful eye).
Installment plans are gander dancing
To their music most entrancing
And our thoughts are on financing
  Something *more* we want to buy.

So these cunning Charleston capers
On our stage and in our papers
Have been outclassed quite often
  (In a million homes perchance).
When this jaded Jane besotted
Threw a mean hoof as she trotted,
Swung her arms and kicked and squatted—
  Through her dance.

But perhaps we have been giving
Hell to "High Cost of Living,"
Hung the onus on this lady
  (This erratic dancing dame)
When with Jim and Mike and Abie
Living High—perhaps and maybe—
Was the vamping, doll-faced baby
  We should blame.

Take Care of Me!

You had better take good care of me. Perhaps you don't think much of me at times, but if you were to wake up some morning and realize you did not have me, you would start that day with an uneasy feeling.

From me you get food, clothing, shelter and such luxuries as you enjoy.

If you want me to, I'll get you an eight-cylinder automobile and a beautiful home.

But I am exacting. I am a jealous mistress. Sometimes you appear hardly to appreciate me at all—you make slighting remarks about me and neglect me.

Considering the fact that you need me not only for the material things of life, but spiritually as well, I wonder that you slight me as you do at times.

What if I should get away from you? Your happiness would flee, for a time at least, and your friends would wonder what sort of fellow you were, and your wife would worry and your bank account dwindle.

So, after all, I am pretty important to you. Cherish me—take good care of me and I will take good care of you.

You ask who I am? I am your job.

The Ties That Bind

Railroad ties! Stretching far and wide, they help to tie the nation in closer bonds.

Florida gets its daily bread from Western wheat fields by rail. Oregon's woodsmen keep warm with Massachusetts woolens—delivered by rail. The Iowa wheat belt seeks shelter under Oregon's lumber—brought across the country by rail.

This is more than a job of fetching and carrying. It is a process that changes sectional wealth into national welfare. It is a work that intimately links the well-being of the people with the well-being of the railroads—for if a railroad prospers it is because that railroad has helped its territory to prosper.

Observe how this works out. The railroad in good financial condition is able to attract capital for improving its facilities. Then more freight can be handled. Crops can be moved faster. Business in general speeds up. Everybody benefits. For adequate transportation is essential to national prosperity.

It comes down to this. Now that many of the roads are beginning to earn a fair return, let us recognize that this is a good thing for the nation at large, because their financial soundness will enable them to render a satisfactory service today and to build for our growing transportation needs of tomorrow.—*Western Electric Company.*

Is That So?

She—I notice that men become bald much more than women because of the intense activity of their brains.

He—Yes, and I notice that women don't raise beards because of the intense activity of their chins!

NEW DEVICES

Flexible Fixture Hanger

A new type of flexible fixture hanger, known as the type ALC, which includes a junction box of ample size, is being marketed by the Crouse-Hinds Company, Syracuse, N. Y. The hanger is designed for supporting suspension type fixtures with ½-inch conduit stem. The fixtures are suspended from a universal joint which assures that the fixture will hang plumb. It also prevents breaking the fixture stem at the point of suspension, due to strains set up by the wind or by hitting the fixture with a stepladder or the like.

Type ALC Fixture Hanger with Fixture

The universal joint permits the fixture to swing through an angle of about 20 degrees in any direction from the perpendicular.

To remove a fixture it is only necessary to take off the cover of the Condulet, disconnect the fixture wires and slide the supporting nipple out of the groove in the Condulet, thus removing the entire fixture as a unit.

The back of type ALC conforms to the shape of the conduit so that it can be mounted close to the ceiling even though the ceiling is inclined. It can also be used close to the roof when the roof is flat or inclined at practically any angle. This feature is especially valuable for use with roofs of saw-tooth construction.

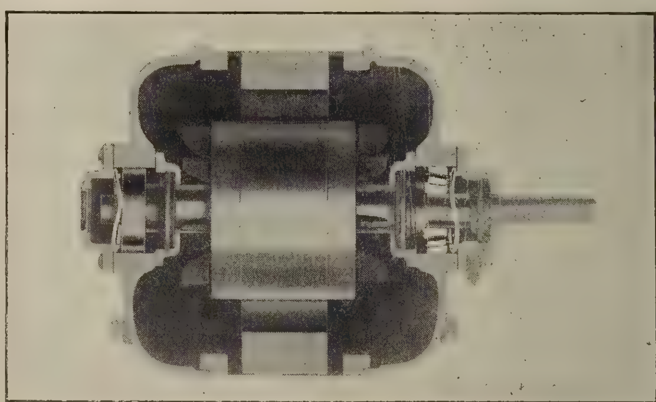
The cover is fastened with one screw. The fixture stem cannot turn or twist in the joint in such a manner as to injure the wires or connections.

Automatic Rotor Re-Centering Bearings for Electric Motors

To insure a continuous uniform air gap in motors, the Howell Electric Motors Company, Howell, Michigan, has brought out a complete line of motors with anti-friction bearings, in which any looseness in the bearing, caused by wear or otherwise, is instantly and automatically taken up, so as to keep the rotor of the motor continually centered with a uniform air gap. This is accomplished by the use of a Timken tapered roller bearing, shimmed with a fluted wire spring which acts as a compression spring.

The inner race or cone of the Timken bearing is fitted on the shaft with a light press fit. The outer race or cup is fitted into the housing of the motor end bell with a sucking fit which allows creeping of the outer race. The spring is held tight against this outer cup by the outer grease cap; pushing the cup tightly against the rollers; and keeping the bearings tight at all times.

This type of bearing is put in each end of the motor and accomplishes the following: It keeps the rotor automatically centered at all times, keeping the air gap uniform. The spring allows for any lateral expansion of the shaft which might occur due to heat. The spring



Cross Section of a Motor Showing How the Compression Spring Presses Against the Outer Bearing Race and Keeps the Bearing Tight

keeps the bearings tight at all times so that the bearing does not need to be adjusted for wear or other looseness. It causes bearing to run more quietly.

Timken tapered roller bearings of nickel molybdenum alloy steel are used throughout this line. These bearings are arranged for grease lubrication and effective seals are used to keep the grease in and to keep out foreign matter, such as dust, dirt or abrasives.

The motors can be mounted in any position without changing the end bells. They will operate in any vertical position as well as horizontal, as these bearings have a thrust capacity equal to their radial capacity.

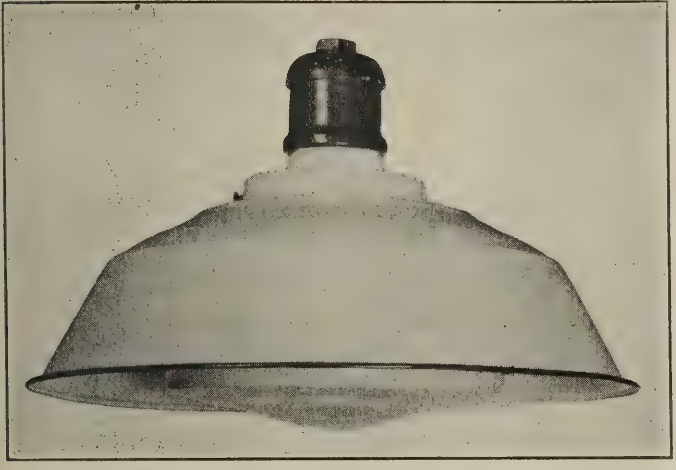
These motors with Timken tapered roller bearings are

offered by this Company in all types and sizes in addition to the regular rotor recentering sleeve bearing.

Enameled Reflector with Diffusing Globe

A Glassteel diffuser, consisting of a diffusing glass globe and a white porcelain-enameled reflector which directs most of the light downward, has been placed on the market by the Westinghouse Electric and Manufacturing Company. This unit is designed particularly to eliminate glare and soften shadows.

The reflector has six openings at the top which permit

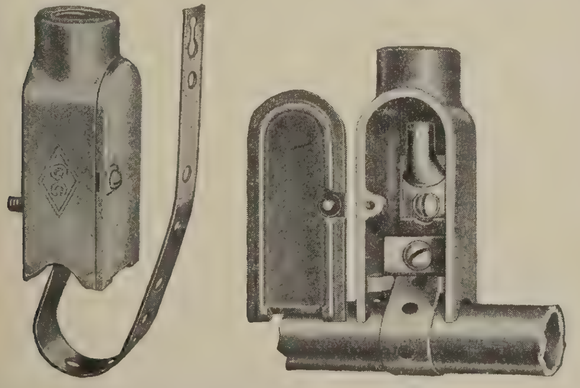


Westinghouse Glassteel Diffuser

some light to reach the coiling, reducing the contrast between the lighted area below the unit and the space above it. It is equipped with a bayonet extension for attaching to the bayonet-heel socket. The breakage hazard in glassware used with the diffuser is greatly minimized by the reflector which protects this glassware from destruction. The diffuser is made with both 10 in. and 12 in. glass.

Condulet for Ground Connection

Condulets for grounding the service wire and the conduit system are now being made by the Crouse-Hinds Company, Syracuse, New York. These condulets known



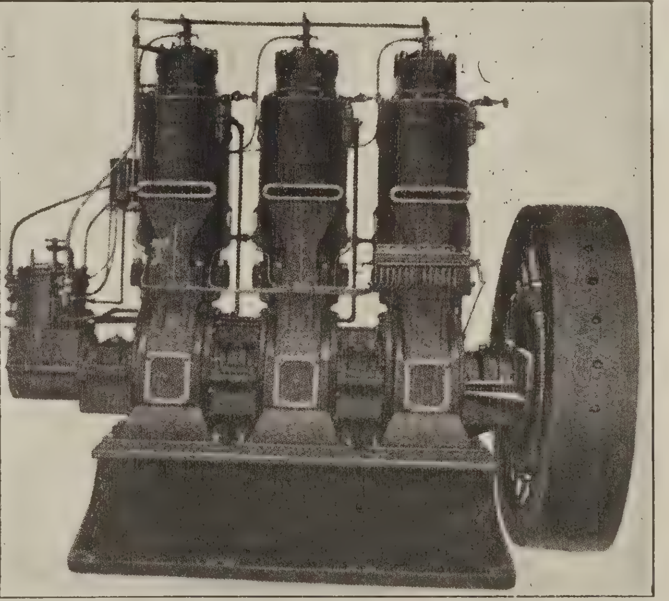
The Grounding Condulet Shown Complete and Also as Applied to a Water Pipe with Cover Removed

as type G C meet the National Board of Fire Underwriters requirements for a well grounded system with ground wires throughly protected from mechanical injury throughout their entire length. The electrical connections within the condulets have ample carrying capacity and contact surface and the condulets are provided with necessary tinned copper grounding straps and lugs of ample size to take the maximum size of ground wire for which they are listed.

The clamping means provided for the strap or straps effect a rigid mechanical and electrical connection between the condulet and the water pipe. After the connections have been made a cover completely encloses and protects the connections, but may be opened for inspection at any time without disturbing the connections. These condulets are furnished in three sizes, depending upon the size of ground wire used. These are GC 1 for ground wire No. 10 to No. 6; GC 2 for No. 4 to No. 1 wire, and GC 3 for No. 0 to No. 000 wire.

Flywheel Type Alternators for Engine Drive

The Ideal Electric & Manufacturing Company, Mansfield, Ohio, which recently brought out a new line of motors called the "flywheel type," is now in a position to furnish this machine as engine type alternator. This type of alternator construction creates a self-contained power unit, being an integral part of the engine, occupying considerably less space than the old conventional design;—it does away entirely with a generator foundation.



Ideal Flywheel Type Generator Driven by a Venn-Severin 300 Hp. Oil Engine

The stator is supported by a cradle included with the casting of the main bearing housing. With the same rotor weight, the flywheel effect of the flywheel type alternator is nearly twice that of the conventional design. If extra heavy flywheel effect is desired, a double rim can be used.

This type of alternator, therefore, adapts itself admirably to the "overhung" type without auxiliary flywheel, and the problem of incorporating the necessary flywheel effect in the alternator has merely become a question of bearing limitations. An exciter or any auxiliary machine may conveniently be belted to the flywheel rotor, thus saving an auxiliary pulley.

The alternators are built for voltages up to 2300 and in sizes up to 125 kva.

General News Section

The Norfolk & Western has granted a wage increase of $4 a month to its clerical employees and an increase of 2 cents an hour to car inspectors.

The Interstate Commerce Commission has postponed the effective date of its automatic train control order in the case of the Lehigh Valley from March 31 to July 18.

The Interstate Commerce Commission has modified its second train control order, of January 14, 1924, to authorize the Louisville & Nashville to make its installation between New Orleans, La., and Mobile, Ala., instead of that portion of its line prescribed by the order.

The Interstate Commerce Commission has authorized the Chicago, Milwaukee & St. Paul to install an automatic train-stop or train-control device upon that portion of its line between Perry, Iowa, and Manilla, Iowa, in lieu of the territory specified in the order of January 14, 1924.

The Interstate Commerce Commission has modified its second automatic train control order to authorize the Chicago & Eastern Illinois to install an automatic train control or train stop device upon that portion of its line between Danville, Illinois, and Clinton, Indiana, in lieu of the territory specified in the order of November 2, 1925.

R. B. Fisher, general sales manager of the Buda Company, Harvey, Ill., has been promoted to vice-president in charge of the sales and engineering departments of the railway division. He entered the employ of the Buda Company in 1910 as an assistant engineer, and later was promoted to chief engineer and more recently to sales manager.

The locomotive shops of the New York, Chicago & St. Louis at Frankfort, Ind., were mostly destroyed by fire on March 9, estimated loss, including damage to locomotives, $500,000 or more. The fire is said to have started from an "oil burner" in the roundhouse. The roundhouse was a new one. Press reports say that about 600 men will be temporarily thrown out of work.

The Pyle-National Company, manufacturers of turbo-generators, locomotive headlights, floodlight projectors and other railway electrical equipment, and the Oliver Electric & Mfg. Co., manufacturers of electrical fittings and wiring appliances, have established a branch office in the Boatmen's Bank Building, St. Louis. This office is in charge of W. M. Graves, Jr., sales engineer, representing both companies.

The "Pine Tree Limited" of the Boston & Maine, the through fast express put on between Boston and Portland last autumn, averaged 177 passenger per trip in each direction, in January, and 187 in December. On the day before Christmas, the number of passengers eastbound was 961, requiring a second section of the train. Since this train was put on, the sale of tickets between Boston and Portland has increased about 9 per cent while, on the Portland division as a whole, and on the entire Boston & Maine system, the passenger traffic has continued to fall off. From this it is concluded that the new train has stimulated traffic; but just how many of its passengers were diverted from other trains has not been precisely determined.

Trico Fuse Manufacturing Company, Milwaukee, Wis., has made a number of changes in its plant. The electrical testing laboratory has been enlarged and new equipment installed. The offices have been enlarged and new lighting equipment has been installed in the factory. The sales organization has been increased by the appointment of H. E. Hartstein, eastern sales manager; P. Rypinski, central sales manager, and F. C. Geiler, western sales manager.

General Electric Company

The annual report shows that net sales in 1925 totaled $290,290,166 as compared with $299,251,869 in 1924 and that profit available for dividends was $38,641,217 in 1925 and $39,235,548 in 1924.

Orders received during the year 1925 were $302,513,-380, compared with $283,107,697 in the year 1924, an increase of 7 per cent.

Unfilled orders at the end of the year were $77,860,000, compared with $68,958,000 at the end of 1924.

	1925	1924
Net sales billed	$290,290,166	$299,251,869
Less: Cost of sales billed, including operating, maintenance and depreciation charges, reserves and provision for all taxes	257,479,491	264,909,538
Net income from sales	$32,810,675	$34,342,331
Income from other sources	10,360,068	10,793,352
Net income	$43,170,743	$45,135,683
Less: Interest and discount cn debentures and other interest payments, premium on retirement of 5 per cent debentures and additions to general reserve	4,529,526	5,900,135
Profit available for dividends	$38,641,217	$39,235,548
Less: 6 per cent cash dividends on special stock	1,735,576	1,195,405
	$36,905,641	$38,040,143
Less: 8 per cent cash dividends on common stock	14,407,544	14,404,980
Surplus in excess of cash dividends	$22,498,097	$23,635,163

Government Control Proposed for Rhodesian Railways

Brigadier General Hammond of the British army, who was commissioned to make a report on the Rhodesian Railways, has issued his report which recommends that, after adequate deductions have been made for operating expenses and a fair return on the investment, three-fourths of the earnings remaining be applied in reducing rates, allowing the private companies to retain one-fourth, according to the Times (London) Trade Supplement. He found the rates charged, generally speaking, not excessive, but suggested some places where reductions might be made under the basis he proposed. He recommended the improvement of the route to the sea via Beira rather

than the building of a new line to another port. The low capital cost of the lines in existence—£6,896 per mile as against £10,327 in South Africa—was noticed and the private companies were acquitted of the charge that they have "watered" their stocks.

Graybar Electric Company Makes Changes

F. A. Ketcham, general manager of the Graybar Electric Company, Chicago, with headquarters at New York, has been promoted to executive vice-president, with the same headquarters. George E. Cullinan, general sales manager, with headquarters at New York, has been elected a director and vice-president in charge of sales. W. B. DeForest, Kansas City branch manager, has been appointed sales manager of its New York office. Mr. DeForest was born in Nemaha County, Kansas, on July 27, 1888. After his graduation from high school in 1904, he served with the Missouri & Kansas Telephone Company. In April, 1909, he entered the employ of the Western Electric Company as a salesman at its Kansas City office, and subsequently held successively a number of important positions. In 1911, he was made assistant telephone specialist at Kansas City; a year later he was transferred to St. Louis, and then was recalled to Kansas City, remaining there until August, 1918, when he was made sales manager of the Oklahoma City branch of the Western Electric Company; the following year he was appointed sales manager, and later, manager at Kansas City. With the incorporation of the Graybar Electric Company on January 1 of this year, as the successor to the supply department of the Western Electric Company, Mr. DeForest continued in his position as manager of the Kansas City branch, until his new appointment as sales manager of the New York office. Robert Davie, of the New York sales office, has been appointed district sales development specialist for the western district, with headquarters at Kansas City, Mo. This territory will include the cities of St. Louis, Omaha, Denver, Salt Lake City and Memphis. Mr. Davie will be in charge of all engineering work in connection with the sale and installation of the application of electrical amplification apparatus. The Graybar Electric Company has removed its Providence, R. I., branch from 233 Harris avenue to its new building at 194-196 Richmond street. The building, which comprises offices and warehouse, is two stories in height and is of the reinforced mill type construction. It contains nearly 13,000 sq. ft. of floor space.

N. Y. Railroad Club to Hear Paper on Electric Drive for Buses

At the next meeting of the New York Railroad Club, to be held at the Engineering Societies' building, New York, on April 16, H. L. Andrews, assistant engineer, railway department, of the General Electric Company, will present a paper on Gas-Electric Drive for Motor Buses.

Venezuelan Line to Be Electrified

The La Guaira & Caracas, a 23-mile line in Venezuela owned by British capital, will be electrified, according to the Times (London). The journey over the railway now requires two hours and electrification will reduce this to an hour and a quarter. One motive for the improvement is prospective highway competition due to road improvement. The cost of the work is estimated at £130,000.

Personals

H. B. Gay, sales manager of the Electric Storage Battery Company, Philadelphia, Pa., manufacturers of Exide batteries, has been appointed to the position of vice-president of the company. In his new position he will still continue in charge of sales. Mr. Gay is a graduate of Cornell University. He entered the employ of the Electric Storage Battery Company in June, 1901, as manager of the company's Baltimore office. In May, 1903, he was transferred to Cleveland, Ohio, as manager of the Cleveland branch. He continued to serve in that capacity until March, 1920, at which time he was transferred to the factory at Philadelphia, Pa., as acting sales manager and four months later was appointed to that position permanently.


H. B. Gay

C. G. McCaulley, formerly superintendent of signals of the Florida East Coast, has been appointed vice-president of the E. A. Lundy Company, Pittsburgh, Pa. He entered railway service as a track laborer on the Pennsylvania on April 7, 1897, and from December, 1899, until April, 1901, held the positions of switch tender, tie inspector and leverman. He resigned from the latter position to accept one in a car shop and resigned on September 1 of the same year to enter the employ of the Union Switch & Signal Company, as a helper on the construction of the Pittsburgh terminal interlockings. Until March 1, 1907, he was employed in the signal department of the Pennsylvania at Pittsburgh, Pa., resigning to become supervisor of signals of the Washington Terminal Company. He was later promoted to supervisor of tracks and signals. He resigned on March 1, 1919, to become engineer of construction in charge of the installation of the Jacksonville terminal interlockings of the Atlantic Coast Line, which position he held until January 1, 1920, when he


C. G. McCaulley

was appointed assistant superintendent of the Jacksonville Terminal Company. He held the latter position until May 1, 1920, when he was promoted to superintendent, which position he held until February 1, 1925, when he resigned to become superintendent of signals of the Florida East Coast at St. Augustine, Fla., which position he has held until his recent appointment.

Louis D. Moore, formerly electrical engineer with the Missouri Pacific at St. Louis, Mo., has recently accepted a position as railway sales engineer with the French Battery Company of Madison, Wis., with headquarters at Chicago. Mr. Moore attended high school and Washington University night school at St. Louis, Mo. In March, 1910, he was appointed office assistant to the electrical engineer of the Missouri Pacific and six years later was promoted to electrical engineer of this road which office involved the responsible charge of the electrical work including lighting of stations, shops, power facilities connected with all kinds of railroad equipment, several high tension industrial substations, a street railway automatic substation, a short interurban line and industrial trucks. Mr. Moore is a member of the American Institute of Electrical Engineers, Illuminating Engineering Society, National Electric Light Association, St. Louis Electrical Board of Trade and St. Louis Railway Club. He continued in the capacity of electrical engineer for the Missouri Pacific until his recent appointment with the French Battery Company, effective March 15.

Obituary

Thomas G. Whaling, who was vice-president of the Westinghouse Lamp Company, died suddenly at the Fifth Avenue Hospital, New York City, on March 1. Mr. Whaling joined the Westinghouse Lamp Company in 1906, as assistant to the manager and held the successive positions of sales manager, assistant general manager, general manager and vice - president He was widely known in the electrical industry as one of the pioneers and early leaders in the lamp industry. Prior to his connection with the Westinghouse Lamp Company, Mr. Whaling was secretary and treasurer of the Milwaukee Electric Company of Milwaukee, Wis.

T. G. Whaling

Mr. Whaling was born in Milwaukee, Wis., in 1878. He was graduated from Sheffield School of Yale University in 1900 and was a member of the Yale and Regent Clubs. He was also a member of the Railway Club, National Electric Light Association, New York Electrical League, Illuminating Engineering Society and Association of Railway Electrical Engineers.

Trade Publications

Condulets and Fuse Cut-Outs is the title of a large illustrated folder issued by the Crouse-Hinds Company of Syracuse. Numerous photographs are shown in which are pointed out the various ways that the several types of Condulets may bs used.

The Arrow Electric Company, Hartford, Conn., has just issued its illustrated catalogue No. 3, covering its line of heater switches. A number of new devices have been added and some of the lines have been extended.

"Electric Heat in Industry" is the title of a new, 32-page illustrated bulletin just issued by the General Electric Company and bearing the number GEA-261. This bulletin deals with the advantages of electric heat for various industrial applications.

Pennsylvania Pump & Compressor Company, Easton, Pa., has recently issued its bulletin No. 126 illustrating and describing Duplex single stage and two stage cross compound air compressors, class DB and DE. The compressors are designed either for belt drive or direct connection to electric motors.

Installation and Maintenance of the Gould Simplex System of car lighting is the title of bulletin No. B-21 recently issued by the Gould Coupler Company, New York. The various types of Gould car lighting equipment are illustrated and described and the latter part of the book is devoted to circuit plans of the different Gould regulating panels.

Sangamo Electric Company, Springfield, Ill., in its bulletin No. 70 presents complete instructions relative to Sangamo type H single and polyphase watt hour meters. Photographs showing the interior of the instruments are given and full notations referring to the various parts of the text explain the meters in detail. The bulletin contains 24 pages, the last four of which give wiring diagrams showing all of the uses to which the type H meter may be put.

An industrial control catalogue has been issued by the General Electrical Company, bearing the number GEA-257. This publication furnishes information on representative lines of industrial control manufactured by that company and includes a reprint of the industrial control section of the company's general catalog; instructive matter on the care and operation of control devices; wiring diagrams of some standard controllers, push buttons and other accessories; reference tables; lists of publications, and other useful information. It has 160 pages, is 8 in. by 10½ in. in size and is bound in paper.

A 64-page publication describing the details of Baldwin-Westinghouse Standard Electric Locomotives for freight haulage service has been published recently by the Westinghouse Electric & Manufacturing Company. It supersedes a similar publication that was published under this subject in 1915. The possibilities of electric railway freight haulage are set forth briefly, pointing out the necessity and consequent advantages of employing electric locomotives in this class of service. The description is confined to the locomotives ranging from 25 to 70 tons. The publication is illustrated. The last eight pages of the book are devoted exclusively to illustrations of some of the Baldwin-Westinghouse locomotives now in freight haulage service.

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Focusing Locomotive Headlights

If a locomotive headlight is to provide the service and pick-up distance for which it is designed, it is necessary that it be kept properly focused. For this reason headlights are usually focused at regular intervals. Different methods are used, those most common being the focusing of the light on a screen a short distance from the headlight or by mounting a pair of discs a short distance apart on the front of the headlight case, the disc nearest the light having several holes drilled in it.

Either of these methods will provide a good beam with sufficient pick-up distance, but they do not align the headlight case. In some instances immediately after a headlight has been properly focused it has been necessary for the engineman to throw the light out of focus in order to get light down on the track where it is needed. In one such case the headlight was so mounted as to throw the beam too high and when the beam was concentrated as it should be, there was practically no light on the track. Thus, without proper aligning of the case, it may do more harm than good to focus the light. Proper alignment is a thing which is often overlooked and is just as necessary as proper focusing.

Preparedness In Motor Maintenance

There are many advantages to be found in the use of machines driven by individual motors, but the fact cannot be overlooked that if such a motor fails for any reason, that particular machine tool becomes useless until repairs have been made to the motor. This may be a very serious matter at times and anything that can be done to prevent the enforced idleness of a machine tool is worthy of consideration.

The motors, like all other mechanical devices, are subject to wear and tear and not infrequently they are badly abused. Under such treatment they will break down and repairs must be made. Fortunately, however, there is often some indication of trouble before the motor actually becomes incapacitated. Certain symptoms point out unmistakably that the machine is going to fail if something is not done to correct the trouble. Of course, this is not always the case, but when it is prompt attention to the motor in trouble will often prevent a complete shutdown of the machine.

A method in use in a large shop where many motors are maintained may serve to show how complete shutdowns are reduced to the shortest possible time. In case of failure of equipment, inspection is made by the chief electrician and numerous tests are made to determine the cause. The machine is checked up to determine the amount of work on hand for this particular machine and as to whether the work can be done on other machines while the motor is undergoing repairs. If the case is urgent an armature winder is sent to cut out the damaged coil if possible. He takes the form number of the machine, maker and type and then proceeds to manufacture a set of coils and cut insulation and get everything in readiness for making necessary repairs to the motor when the machine is not so badly needed. When the opportune time arrives, the motor is taken out of service and repairs are made in much less time than would be possible if the preliminary preparations had not been made. In other words preparedness in motor maintenance, as in other things, goes a long way toward smooth operation and in keeping up production; every maintenance foreman should be ready on shortest notice to make such repairs as will keep the machines in practically continuous service.

"The Changing World"

An official of a large railroad recently stated that any equipment which could show a 20 per cent saving over that now in use would be approved for purchase within 24-hours. This statement probably applies to all kinds of equipment, but as made it was applied specifically to electrical machinery, and is in effect a challenge to both the electrical manufacturers and to the electrical men on the railroads.

This statement comes from only one railroad but is undoubtedly indicative of the changing attitude of all railroad officials toward the adoption of the many new pieces of equipment and processes which are daily being produced by the electrical industry. The railroads have lagged behind the manufacturing industries in the adoption of electrical machinery, but there have been a number of reasons for this apparent reticence.

In the interest of safety it does not behoove a railroad to use certain types of equipment or to adopt certain methods until they have been thoroughly tried out. The roads grew up as steam railroads and in many cases electrical work has been done by all departments in a small way and without adequate electrical organization. In addition to this railroads are spread over large territories and it is more difficult for a supply company to adapt a sales organization to railroad requirements than it is in the case of manufacturing industries. Much educational work has been required which needed to be distributed all

the way down the line from the president of the road to the electrician's helper."

That this work has been well done is evidenced by the statement concerning 20 per cent savings. It is often difficult to prove such a saving even when it exists, but the statement indicates a new order of things and it is up to the electrical men to prove that such savings can be made.

Gas-Electric Welding

Two new processes of fusion welding have been developed by the General Electric Company which promise to do much for the welding industry. One of these methods called atomic hydrogen arc welding consists of passing a stream of molecular hydrogen through an electric arc which is sustained between two non-consuming electrodes. The molecular hydrogen (H_2) on entering the arc is broken up into atomic hydrogen (H) which recombines again a short distance beyond the arc, this recombination being accompanied by extremely high temperature, sufficient to melt molybdenum. The central flame is surrounded by a larger flame of hydrogen which does not pass through the arc.

The second method consists simply of surrounding a regular consuming metallic arc electrode with a reducing flame consisting usually of a mixture of hydrogen and carbon monoxide. Other gases have also been used successfully.

The atomic hydrogen welding method is particularly adapted to the welding of thin sections while the protected arc method is suitable for the welding of heavy sections. In both cases the voltage across the arc is somewhat higher than that across an ordinary metallic welding arc. In both cases also oxygen is excluded from the weld by the protecting flame. The result of this in the case of welding steel is that the weld is extremely ductile; brittleness in a steel weld is usually caused by the inclusion of oxides. In addition to this, the processes have been used for welding new metals in the non-ferrous group and for welding two different metals together.

The torches or electrode holders are somewhat complicated in appearance, but they are light weight tools and are not difficult to manipulate. The two processes have many commercial or manufacturing possibilities and will probably later be used extensively for repair work.

The June Convention

It is not too early to begin laying plans to attend the June meeting of the Association of Railway Electrical Engineers. As has been the practise in previous years, this meeting will be held in Atlantic City at the Hotel Dennis at a time which coincides with the convention of sections four and five of the American Railway Association. The meeting date for the Association of Railway Electrical Engineers is Monday, June 14, at which time the progress reports of the various committees of the association will be presented.

The opportunity to inspect the exhibits of the manufacturers of railroad equipment is one of immense benefit to every electrical engineer, as each succeeding year brings more and more applications of electrical energy to the railroad field. The exhibits as heretofore will be located at Youngs Million Dollar Pier.

New Books

The Mechanical World Electrical Pocketbook 1926 Edition. By Emmott & Company, Ltd., 65 King Street, London, 396 pages, illustrated, diagrams and tables, 4 in. by 6¼ in. Bound in cloth. Price 35 cents.

A number of new features have been included in the present issue of the handbook. Among these are a section on the joining of conductors and another on magnetic chucks and magnetic clutches. Industrial application of electro chemistry giving information on the latest developments in the electro deposition of metals, electric heating and cutting with the electric arc are also features included in the latest edition. Although the notebook reflects British practice to a considerable extent, nevertheless much of the information contained in it is universal in its application.

Insulated Electric Cables. By C. J. Bearer, M. I. E. E. Published by D. Van Nostrand, New York, 264 pages, illustrations, diagrams and tables, 7¼ in. by 9½ in. Bound in cloth. Price $11.00.

The subject matter has been arranged in two parts—namely Materials and Designs, and Manufacturing and Installation. The present volume is devoted entirely to the subject of materials and design. In a book as large as this, it is possible to go into great detail with regard to the materials used in the manufacture of insulated electric cables and the author has made a very comprehensive and exhaustive presentation of the subject. The steps leading up to the discovery of many of the materials as well as the original and subsequent methods of obtaining them in commercial quantities are fully treated and are indicative of the general purport of the book. There are a large number of illustrations and diagrams which serve admirably to emphasize the important points brought out by the author. In short, the book may be considered as a valuable addition to the literature in this field and will take its place as a reference book for those interested in the subject of cable manufacture.

Safety Rules for the Installation and Maintenance of Electrical Supply Stations. By the Bureau of Standards, Washington, D. C., 56 pages, 5 in. by 7½ in. Paper binding. Price 10 cents.

Previous editions of the National Electrical Safety Code have been published in complete form but there has been some demand for a smaller handbook containing a single part of the code and it is in response to this demand that the fourth edition is being issued not only as a whole but also in separate publications dealing with the several subjects covered.

The present volume contains part one, dealing with generating stations and substations along with the grounding rules contained in section nine. The rules as given in this book are the result of the revision which has been carried out according to the procedure of the American Engineering Standards Committee and the revised rules have had the approval of the sectional committee organized according to those rules of procedure. The various sections of the book cover the following subjects: Rules covering methods of protective grounding of circuits; protective arrangements of stations and substations; protective arrangements of equipment; rotating equipment; storage batteries; transformers, induction regulators, rheostats, ground detectors and similar equipment; conductors; fuses, circuit breakers, switches and controllers; switchboards; and lightning arrestors.

Battery Room of the D. L. & W., Hoboken, N. J.

Maximum Results From Car Lighting Batteries

Temperature and Height of Solution Are Most Important Factors and Should Always Be Given Consideration

By Geo. W. Wall
Car Lighting Foreman, D. L. & W. R. R.

IN recent issues of the *Railway Electrical Engineer*, car lighting practice as carried on on the Lackawanna has been described in detail. Battery maintenance on this road has been developed to a high degree, and since one of the most important factors in the maintenance of good lighting is the care which is given to the battery equipment, it will be interesting to study some of the practices of this road. The care of battery equipment not only includes the battery itself, but is concerned with its housing. For this reason it may be well to start with requirements of the battery box.

Battery Box Maintenance

The battery box is given attention by the car shop forces as the car goes through the shop. Most of the floors are merely laid in the box and are easily removable. The floor is removed if worn or eaten away by the action of the electrolyte and the interior of the box scraped and washed with a strong alkaline solution to neutralize the acid. The supporting frame of the box is gone over and, if eaten away, is replaced with new members so that there is no danger of insufficient strength to support the battery. The metal interior of the box is painted and a new floor applied if the old one is eaten away, or so badly worn as to interfere with the sliding of the trays in or out of the box. Hinges and hasps are renewed at this time if they show evidence of weakness, and the box is put in such condition generally that there is no danger of its failing in service.

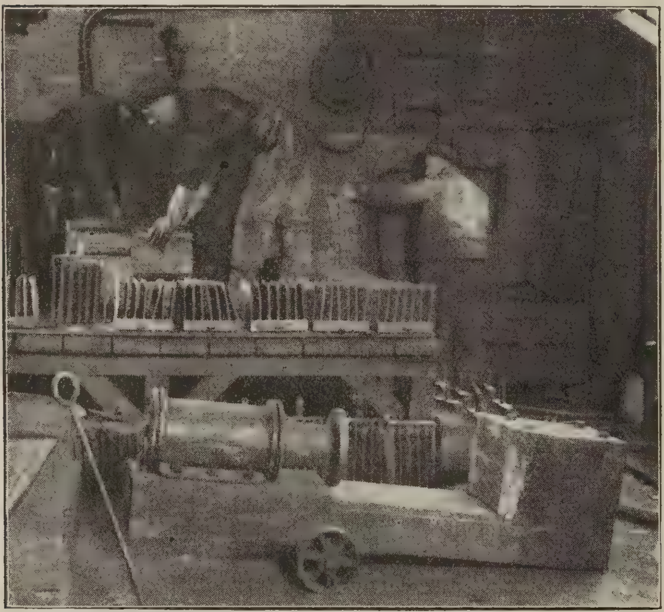
Up to the present time, the battery cleaning room has been located at the terminal and the car is brought to the battery room for removal of the battery before it goes in the shop. However, in the case of a battery under three years old, it is not necessarily removed, but may stay with the car during the shopping. It has been found that neither the box nor battery require any considerable repair within the first four to five years and the only attention required is a thorough inspection, painting of trays, maximum charge and adjustment of gravity. The battery is, of course, disconnected if left in the car during the shopping period, which is ordinarily about three weeks, so that there is no danger of trouble from short circuits while the car is going through the shop.

Care of Connections

The set will hold its charge with very slight loss during this period and a short charge and often none at all is required before the car again is put into service. Before it goes in service the connectors are removed and the lugs cleaned of corrosion. Even though the terminals and lugs seem to be made up tight oxidization of the positive terminal takes place and has been found at times to seriously effect the operation of the equipment. It increases the resistance of the junction and as there are sixteen connections to the positive lugs, the added resistance to the flow of current is sufficient in some cases to affect the charging rate considerably. The regulator voltage setting is fixed and any added resistance in the circuit cuts down the amount of current flow. This same resistance cuts down the voltage and current delivered by the battery on discharge and is therefore a disadvantage both on charge and discharge. When batteries are in service for several years before removal these unnecessary terminal losses may amount to two volts or more, and are apt to

upset the regulation considerably in very hard service where the battery needs all the charge available.

If the battery is in such condition that it is removed from the car before shopping, it is given a complete overhauling and put in the best possible condition. It is not, however, held out of service until the car comes out of the shop, but is put in any car that takes a battery of the same type and capacity, thus keeping it in practically continuous service during its useful life. The cleaning process is much the same as practiced in any battery shop. Possibly some groups are scrapped before the last bit of service is taken from them, but there is no economy in putting doubtful groups back in service, only to have trouble in a few months which will force the car out of service and into the shop for battery renewals. Switching operations of this kind are costly and holding cars out of service for repairs that might have been avoided is poor maintenance, and reduces the efficiency of the service as well. Under the present system, cars are seldom cut out for battery replacement and very few groups



Dismantling Bench and Washing Tank—Portable Battery Plate Press Shown in Foreground

go bad in service. Positive group life of from eight to ten years in this service would indicate that very few groups are scrapped before their time.

Rubber Jars Replacing Lead

In common with other work, the failure of the lead lining has been a source of great trouble and expense during the past few years. It is impossible to set a figure on the losses due to this one factor, but the shortened life of groups, lining and tray renewals, floors and metal boxes destroyed, release of electrolyte to attack practically everything with which it comes in contact, to say nothing of light failures, has harassed the department continually. For over four years, the lead lining has been on its way out and during the last two years all replacements have been made with rubber jars. The result has been a very material reduction in the total number of leakers, although the percentage among the lead linings still in service is practically as high as ever. The rubber jars first put in service have already given as long life as the average of the lead lining and are apparently as good as ever. No evidence of their becoming brittle or warping being present. This result is not surprising even in face of the failure of the rubber jar of a decade ago. Rubber compounds are adapted to the requirements of service today and the working conditions are immeasurably im-

A Comparison of the Lead Tank and the Rubber Tank

proved, all tending to make the jar a sound proposition. At the present rate of replacement of all leaky linings with rubber jars, whether they develop in the shop or in service, two years more should witness the total banishment of the troublesome lining and a material reduction

Replacing Acid Eaten Floors of Battery Boxes

in battery cost is in prospect. It is, however, necessary that the rubber jar be kept up to the present high standard if full advantage is to be had from this change. When the battery is removed from the car, it may not need a general overhauling but, due to the long periods it is in

service before removal, it is necessary to check the maximum gravity point very carefully in order to be certain that the cells go out for service once more with correct gravity. This feature is checked up whether the set requires a minor or general overhauling. There is a very slow loss in gravity due to the slight gassing that takes place in service, but it has never proved serious enough

Painting Battery Boxes Is An Important Detail

to require adjustment until the set is brought into the battery house.

As pilot cell gravity readings are used as a check on the performance of the equipment, it is quite necessary that the maximum gravity be known so that proper corrections may be made to compensate for varying conditions. The effect of temperature variations on gravity

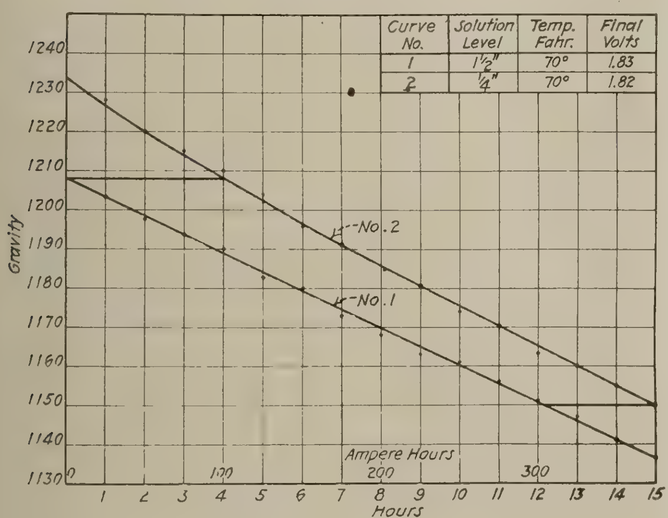


Fig. 1

and capacity as well as the effect of the gradual lowering of the solution level must be allowed for in pilot cell operation.

In suburban service the above effects are of more importance than in thorough service, because of the greater degree of variation to which the cells are subject.

Effect of Temperature on Gravity Readings

As it is possible to arrive at a rather accurate conclusion as to the state of charge of a lead cell by means of gravity readings, considerable dependence is placed on such readings. At monthly intervals, or as near to that period as practical operation will permit, a gravity and height of solution reading is taken. These readings are not, however, taken at face values owing to the proved effects of temperature and solution level changes.

The maximum gravity of a fully charged cell is set at 1.210 at 70° F. and at one and a half inches over the plate top. As the gravity range of a lead cell on a full discharge, taken at the 25 ampere rate, is about 70 points, it might be assumed that the standard curve for the battery may be used at all times and a cell reading of say 1.175, would therefore always indicate a cell with one-half its capacity still available providing, of course, that the maximum was 1.210. There is an opportunity for a very large percentage of error if figured in this way and allowance should be made for conditions existing at the time a reading is taken. It is not necessary that exact corrections be made except in special cases, but experience has shown that at least some allowances should be made if pilot cell operation is to be a reliable indication. Some interesting data has been taken in connection with the effects of the conditions mentioned and this is perhaps a

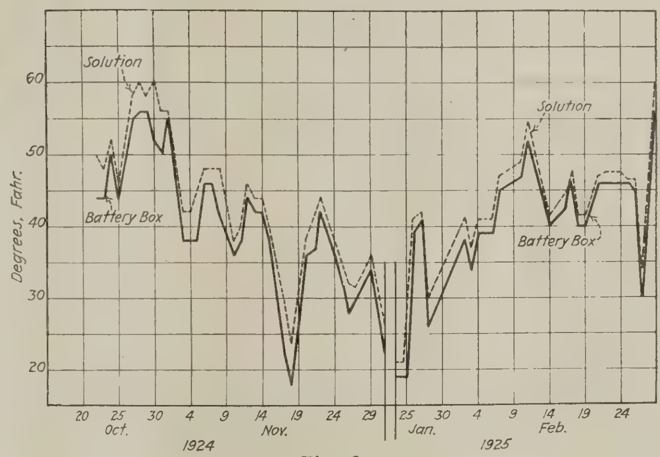


Fig. 2

good place to record it as showing what the extent of such effects may be in practical service where one might suppose it to be unnecessary to go into such detail. The results of some of the tests may not agree exactly with theory inasmuch as they were made under actual service rather than laboratory conditions, but they are perhaps more useful because of this fact as they show to what slight degree the practical and theoretical results vary. There are, of course, several other more or less minor conditions affecting the operation of the battery, but the desire is to determine what considerable errors may be encountered in using the gravity as a measure of the state of charge.

Solution Height Affects Gravity

One of the most important points to determine is how much the maximum gravity of the solution is affected by the lowering of the solution level due to the evaporation of the water from the electrolyte, resulting in a less dilute solution and numerous tests were made in order to arrive at a figure which could be used as a correction to normal from any height of solution over the plates.

The fully flushed cell has one and a half inches over the plates and this is allowed to evaporate down to one-quar-

ter inch before the cells are flushed. The total evaporation amounts to one and a quarter inches and records kept of the result in service as well as shop tests indicate that there is a 25 point increase in maximum gravity of a given cell due to the loss of water or 5 points to the quarter inch. This holds good with a fully charged cell only, and discharge tests made of the same cell, at one and a half inches, and one-quarter inch, show that this gap is slowly closed as the discharge proceeds, finally getting as close as fifteen points at the end of discharge. In the battery house where fully charged cells are to be adjusted as a rule the average of five points per quarter inch is used as a correction constant while in figuring the state of charge in service, when the majority of the cells are not fully charged four points per quarter inch are allowed for corrections as it is closer to the average variation over the whole discharge, and the error is not great enough to cause trouble.

In the following curves are shown the results of tests taken on a cell removed from service, as well as curves showing the temperature conditions under which the cell operated in service. The curves are not shown in the order in which the tests were made as the cell was removed after it had worked long enough to reduce the solution level to one-quarter inch. A smooth curve has been drawn, but the actual readings are spotted in as well.

In Fig. 1 curve No. 1 is shown the test taken with the cell in normal condition. The maximum gravity is shown as 1.208 rather than 1.210 as the cell was tested as it came out of service and no adjustment made. The solution level, temperature and gravity during a discharge to approximately 1.80 volts are given and show the cell to be capable of delivering 375 ampere hours at the 25 amp. rate. Comparisons of the performance of this cell under different conditions are shown in other curves.

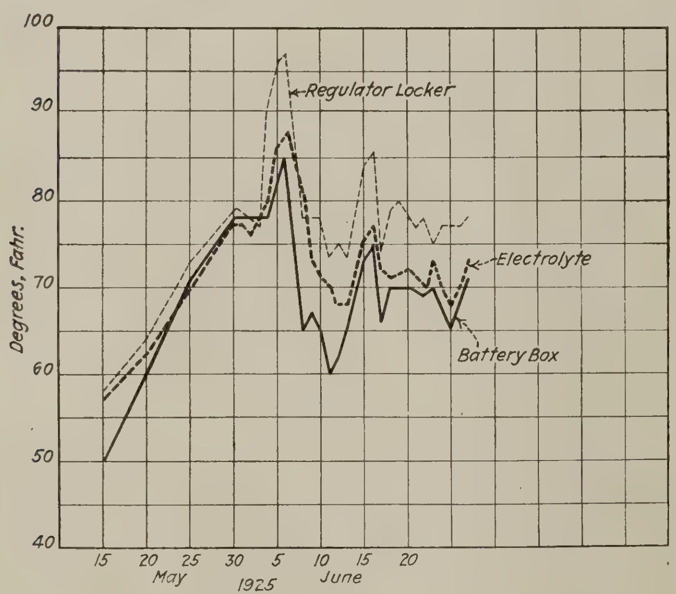


Fig. 3

Curve No. 2, Fig. 1, shows a discharge of the cell at a solution level of one-quarter inch and illustrates the error which may be made by failing to make allowances for change in solution level. The capacity was the same as, in the first curve, but at a gravity reading of 1.208, the cell was 100 amp. hours short of full capacity and would have required a charge of 100 amp. hours plus about 20 per cent for losses or 120 amp. hours total, to charge it fully. If corrected by deducting four points of gravity for each quarter inch loss in solution level the reading would have been 1.188, only one point error, and would have shown the cell to be considerably under full charge. The error would have amounted to four hours of burning if the set had been in actual service in a car. Even at the tag end of discharge the error amounts to about three hours of burning.

Tests were made some years ago to determine how closely the temperature of the electrolyte followed that of the air both in through service and in suburban service.

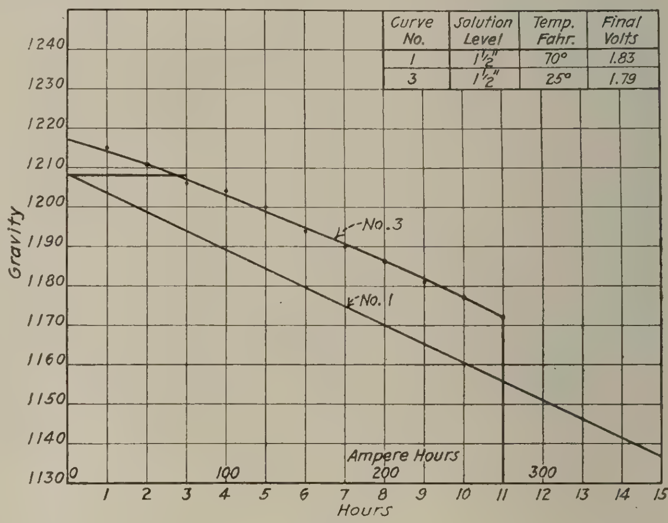


Fig. 4

These tests were repeated during the last year in order to compare results and a part of the readings taken during the winter of 1924-25 and also those of a short time during the summer of 1925 are shown in Fig. 2. The first curves show the temperature of the solution and also that of the air in the battery box. Evidently the battery works at a temperature approximately that of the air for any given day. Only in the event of very sudden changes of atmosphere temperature does the solution fail to approximate air temperature. The curves show two periods of the winter which may be considered as representative of conditions in the area within a few miles radius of the New York district. Another set of curves, Fig. 3, shows how the solution temperature compared with that in the battery box during a spell of terrific heat experienced in this section. The last curve is given merely to show that under such conditions of extreme heat the battery did not heat up sufficiently to cause damage even under the combined effects of charging and high atmosphere temperature. Most interest centers in the curve of winter condition as the cell is shown to be down to 21 deg. and 25 deg. on different days.

In Fig. 4, curve No. 3 shows a discharge of the test cell at 25 deg. F. which was the lowest temperature obtainable for the test. While the difference in gravity at first did not amount to one point to three degrees of temperature, due largely to inability to provide more accurate test conditions, the curve as drawn shows that there was considerable difference at the start of discharge and by the fifth hour the cell was operating at the rate of one point to three degrees of temperature. The error even as obtained under the test conditions amounted to about 70

ampere hours and instead of being fully charged at 1.208, it required 70 + 20 per cent or about 85 ampere hours input to bring it to full charge. Even more important is the loss of capacity due entirely to the cold conditions of the cell. This loss is but temporary, of course, but at 25 deg. F. it amounted to the equivalent of four hours burning of a car as the cell temporarily dropped from a 375 ampere hour cell to a 275 ampere hour cell. Instead of a normal capacity of 375 ampere hours at 1.208, as shown in curve No. 1, there was but slightly more than 200 ampere hours available at this gravity due entirely to the drop in temperature. If the set was working in a

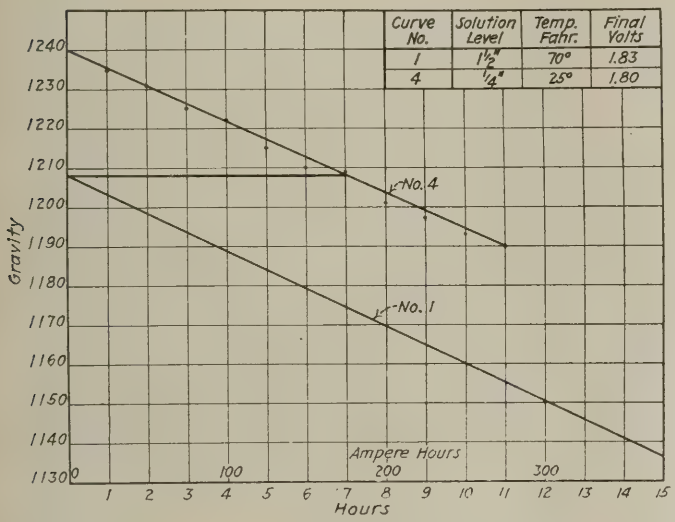


Fig. 5

car, there would have been but eight hours of burning available instead of fifteen.

Following out the test to the logical conclusion, the cell was discharged at a temperature of 25 deg. F. and a solution level of one-quarter inch. This is the extreme condition, but it does occur in service quite often. Also, it occurs at a time when the best of lighting is needed as well as the time when more hours of burning are the rule. Errors made under this set of conditions lead to dark cars and no apparent reason for it unless the proper allowance is made when gravity readings are checked. If proper allowance is made the real state of charges becomes apparent at once.

Curve No. 4 in Fig. 5 shows a discharge of the test cell as just stated. At the reading of 1.208, the cell instead of being fully charged, lacked 175 ampere hours and required 175—20 per cent or 210 ampere hours to fill up this supposedly fully charged cell. As regards its available capacity at 1.208, instead of there being 375 ampere hours available or 15 hours of burning for a car, there were only 100 ampere hours available or but 4 hours of burning when compared with curve No. 1 in which temperature, solution level and capacity are normal. Evidently due allowance must be made when gravity is used as a check or very serious error will occur. Note that the losses as shown in curves No. 2 and No. 3 check almost exactly with curve No. 4, thus proving themselves.

In Fig. 6 the normal curve, first shown as No. 1, is shown as a solid line and curves 2, 3, 4 are shown connected according to the constants of four points of gravity to the quarter inch and one point of gravity per three degrees of temperature. The curves come together closely enough for practical purposes and such variations as there arc, may be laid at the door of lack of laboratory conditions for making the tests.

Very lively interest in the actual conditions under which a battery may be working at any given time is forced upon the supervisory force when pilot cell operation is employed in maintenance work. It is not necessary for the mechanic to take into consideration the possible error although it is to his credit if he does interest himself sufficiently to be able to make corrections on the job and get quicker action because of his ability to "dope it out" rather than pass it on to someone else. Due allowance is made when checking the monthly readings and trouble avoided in most instances as whatever corrective measures necessary may be taken in time.

The curves also serve to show that the tendency to use smaller capacity cells, while desirable as regards first cost, cost of renewal parts, weight, care of handling, etc., must be coupled with due regard for the extreme conditions noted in the effect on capacity of the low temperature at which the cells operate at least part of the time. Averages will not always do, as the car must be well lighted under extremely bad conditions as under more favorable ones, if it is at all possible. In fact, it is even more important to have abundant light under adverse weather conditions, if anything. When delays, due to other causes, harass the operating department and the passenger is

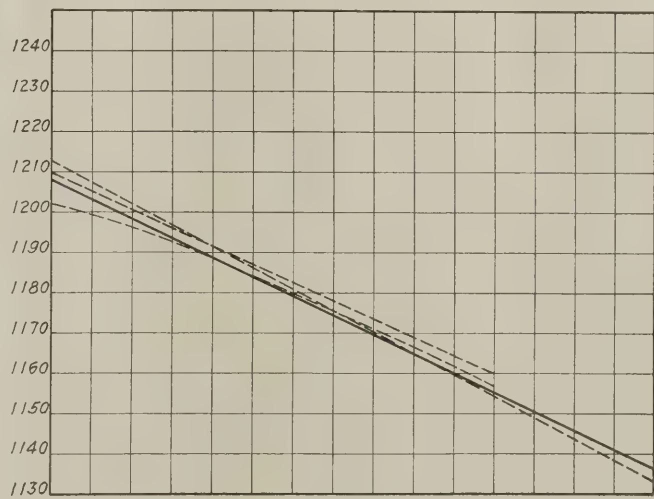


Fig. 6

resentful of delay or inconvenience, it helps mightily to snap on the switch and produce good illumination to take the edge off the complaint and allow some sort of activity to while away the time due to the delay. The short trip passenger seems to be affected a great deal more by delays or any inconvenience than the long distance traveler.

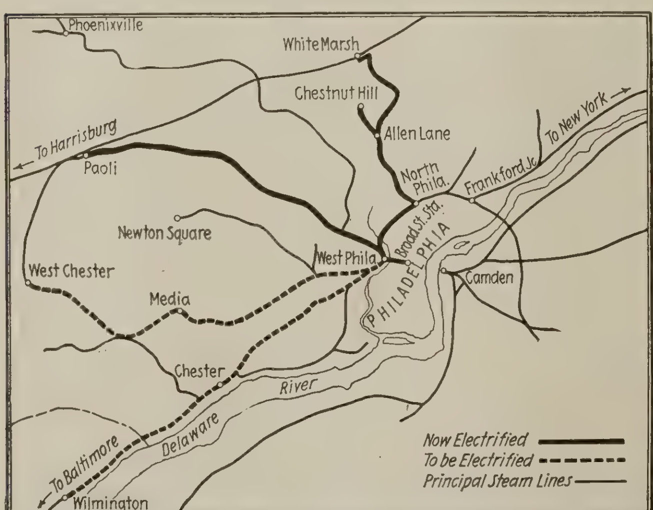
The time to prepare for good results in service is when the car is being overhauled in the shop. Doing the work which has proved necessary and avoiding that which has been found unnecessary required rather careful study of service results. Radical changes on the spur of the moment may serve as an expedient to get over a bad spot, but time must be found to ponder on the cause which upset the operation before successful steps can be taken to avoid a repetition.

Pennsylvania to Extend Electrification

THE Pennsylvania plans early electrification of its lines between Philadelphia, Pa., and Wilmington, Del., and between Philadelphia and West Chester, Pa., via Media. Work on this step in carrying out the program for the ultimate electrification of all suburban lines in the Philadelphia district will be started soon and is scheduled for completion in 1927. It is estimated that the total cost will approximate $10,000,000 exclusive of new electrically equipped cars which will be required.

The directors authorized last fall an expenditure to place under ground all telegraph, signal and telephone wires on the Philadelphia Terminal division and the Maryland division between West Philadelphia and Wilmington. This step is preparatory to electrification and the contract has been awarded and the work is under way.

Electrification of the lines to Wilmington and West Chester is an integral feature of the development of the new passenger station project on the west bank of the Schuylkill river and the subway extension and subway station for suburban traffic at Fifteenth street and the Parkway, Philadelphia. In respect to mileage, it will constitute the most extensive project of the kind on the road,



The Pennsylvania's Proposed Extension of Electrification at Philadelphia

involving four tracks between Philadelphia and Wilmington with double and single track sections between Philadelphia and West Chester. The total number of miles of line electrified will be about 52 and the total number of miles of track will be about 150. The distance to Wilmington is 27.1 miles and to West Chester, 25.5 miles. The total number of miles of line included in the present Paoli, Chestnut Hill and Fort Washington branch electrifications is about 38, with nearly 114 miles of track.

Electrification of suburban lines is necessary before service can be operated through the subway extension to the new underground suburban station, under the terms of the agreement between the company and the city in connection with the construction of a new passenger station in West Philadelphia. Electrical construction and equipment on the new lines will be of the same general types as those used on the Paoli and Chestnut Hill lines. The system of traction will be single phase, 25 cycle, alternating current. The transmission line will carry 132,000 volts, with a normal voltage of 11,000 in the trolleys.

Current will be supplied to sliding pantograph trolleys on the multiple unit cars through a system of overhead

Portion of the Paoli Electrification Which is Typical of the Proposed Construction

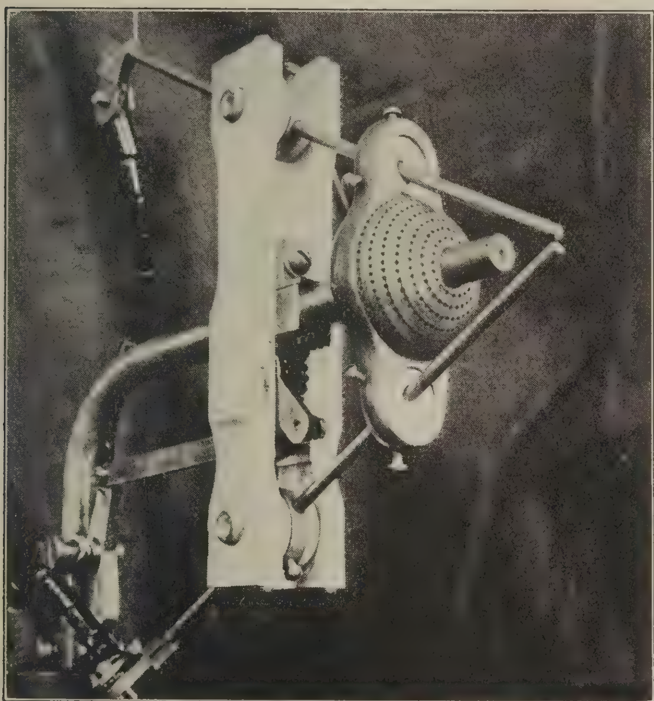
catenary construction, comprising a main messenger, auxiliary messenger and a contact trolley wire. These wires and hangers will be of non-corroding materials. Trolley wires for two tracks will be carried on brackets attached to tubular steel poles, but trolleys for more than two tracks will be supported by cross catenaries. Two single-phase, two-wire signal power circuits will be carried on the catenary structures. Signal control circuits and telephone and telegraph wires between Philadelphia and Wilmington will be in cable and laid underground, and on the West Chester lines these circuits will be either in aerial cable or open wire. The company will buy about 125 new multiple unit cars for the Wilmington and West Chester service.

Along the Pueblo-Apizaco Line, Mexico

Two Gas-Electric Welding Processes Developed

Two Methods of Fusion Welding Exclude Oxygen and Make Ductile Welds

TWO methods for producing ductile welds have been developed by research scientists of the General Electric Company, working in different laboratories hundreds of miles apart. Both of the methods, similar in some respects, mark a decided step in the utilization of the heat of electric arcs in the joining of metal parts or the building of metal structures. The one was developed in the Schenectady research laboratory by Dr. Irving



Atomic Hydrogen Arc Welding Torch, Type 1

Langmuir; the other was developed in the Thomson research laboratory at Lynn, Mass., by Peter Alexander.

In both processes air is excluded from the metal by means of a bath of hydrogen or other gas. The formation of oxides and nitrides in the weld metal is thus prevented, and the fused metal is as strong and ductile as the original metal.

In brief, the method developed by Dr. Langmuir in Schenectady is to pass a stream of hydrogen between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine again a short distance in front of the arc into molecules of the gas, and in so doing liberate an enormous amount of heat, so that much higher temperatures can be obtained with this than with the usual welding methods. Since atomic hydrogen is a powerful reducing agent, it reduces any oxides which might otherwise form on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

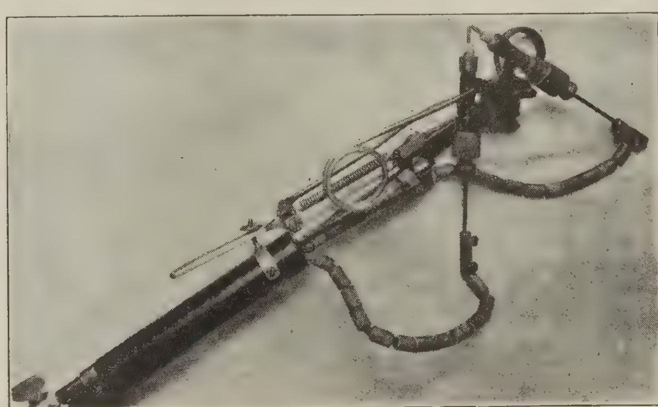
The process developed in the Lynn laboratory by Mr. Alexander is based on the utilization of the chemical and physical properties of hydrogen and other gases in their molecular state. This process aims primarily at the prevention of the formation of the nitrides and oxides in the arc-deposited metal, which limit the ductility of the usual arc welds.

In this process the arc is struck between the metallic wire or carbon used as one electrode and the plate or work to be welded used as another electrode. The crater of the arc is always on the work to be welded. The gaseous atmosphere is supplied in a form of a stream around the arc. Pure hydrogen-water gas, hydrogen-nitrogen mixtures, anhydrous ammonia, methanol vapor and some other suitable gases can be used, according to the nature of the work. The hydrogen-carbon monoxide mixtures were suggested by Professor Elihu Thompson; water gas and methanol are examples of such mixtures.

This process makes the arc welding process more efficient and suitable for the fields which at present are out of its reach. Low carbon steel, alloy steels, and most of the non-ferrous metals and alloys can be welded with success by this process in suitable gaseous mixtures.

Atomic Hydrogen Arc Welding

Fifteen years ago, while studying the loss of heat of the tungsten filaments of incandescent lamps in an atmosphere of hydrogen gas, Dr. Irving Langmuir of the General Electric research laboratory at Schenectady found that at a high temperature the hydrogen gas changed from



Atomic Hydrogen Arc Welding Torch, Type 2

the molecular to the atomic state. In the molecular state, two atoms of the gas are grouped together as a unit; in the atomic state each atom acts as a unit. The molecular form is the more stable, and when the atoms recombine to form the molecules intense heat is liberated.

Dr. Langmuir's study of the filaments in hydrogen was a theoretical investigation. Now, fifteen years later, the results have been applied in a different field—in the development of a new method of welding, by which it is possible to produce welds as strong and as ductile as the original materials.

Continuing the theoretical investigation, Dr. Langmuir found that more atomic hydrogen was formed by passing powerful electric arcs between tungsten electrodes at atmospheric pressure. By directing a jet of hydrogen

from a small tube into the arc, the atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to the molecular form and liberating about half again as much heat as does the oxy-hydrogen flame. In this flame molybdenum, one of the most refractory of metals melts with ease; quartz however, melts less easily, in spite of its lower melting point. This indicates that the metal assists in the action as a catalyzer—which scientists define as a substance which accelerates a chemical change.

By this method, iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes and without oxidation. The rapidity with which such metals as iron can be melted seems to exceed that in the oxy-acetylene flames, so that the process promises to be particularly valuable for welding.

The technical development of this welding process has been the work of several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. These men have developed and tried many types of welding torches, and have tried them under varying conditions. At the same time tests of numerous types of welds have been conducted.

The two electrodes of the torch are tungsten rods, held

Welding with the Atomic Hydrogen Arc

at an acute angle with each other by lava insulators. When not in use, the electrodes are in contact with each other; they can be separated by pressure on a lever mounted on the handle. A set screw is provided for making slow adjustments of the electrodes. The hydrogen is supplied by a tube through the handle. Sufficient gas is used so that not only are the electrode tips surrounded by enough to form the blast of atomic hydrogen but by an additional quantity to surround the work with hydrogen.

Either alternating or direct current can be used. The first mentioned has been found more convenient, and electrodes of smaller diameter can be used. The gas pressure required to operate the torch is very small; in the laboratory, with short lengths of tubing, a pressure of less than one pound per square inch was sufficient with metals up to one-half inch in thickness. For ordinary welding, the rate of gas consumption varies between 20 and 30 cubic feet per hour.

Since the maximum rate of heating is desired in welding, the torch is held close to the metal. Best results have also been obtained when the torch is inclined so that the blast of hydrogen from the torch passes over the pool of molten metal in a direction opposite to that in which the torch is moved along the line of the weld.

Experiments have been conducted with several gas mixtures and various electrode materials. The best results have usually been obtained with tungsten electrodes and hydrogen alone.

Materials of many kinds have been successfully welded by this method. Low carbon steels up to one-half inch in

Torch for Welding in Hydrogen with a Metallic Electrode

thickness have been welded without additional material after butting together tightly. Considerable work has also been done in connection with full automatic welding using a butt joint, and with no metal being added to the seam. A number of welds have been made on seamless tubing having a wall thickness of one-quarter inch and an outside diameter of four inches, and with boiler plate iron one inch thick. Welds on deoxidized copper such as silicon-copper have been made up to three-eighths inch thick metal, giving unusually good sections.

In testing welds made by this process, the welded portions have been twisted and bent double without cracking or otherwise being injured.

Electric Arc Welding in Gaseous Atmosphere

By surrounding the ordinary welding electrodes with an atmosphere of hydrogen or certain other gases, it has been found by Peter Alexander of the Thomson Research Laboratory of the General Electric Company at Lynn, Mass., that it is possible to produce ductile welds. The gas acts as a flux and shield against the oxygen and nitrogen of the air; therefore the formation of oxides and nitrides of iron in the molten metal is prevented. The process originated from the study of metallurgy of the arc-deposited metal and the causes that limit its ductility.

The method is based on the action of molecular hydrogen. This gas at high temperatures, even in the molecular state, is a very active reducing agent. When it surrounds the crater of the arc it acts in the same way as it does in the hydrogen brazing process. Yet certain peculiarities of the process (for example, the extremely high voltage drop at cathode and anode of the arc burning

in hydrogen) are due to the dissociation of the small amounts of molecular hydrogen in actual contact with the craters. Hence the apparent resistance of the arc, and consequently the amount of energy liberated, is about double that when the arc is burning in air.

Consequently the weld is not only ductile, but the operation is much faster. The speed results both from the greater energy of the arc in the hydrogen atmosphere and the fact that beveling of the edges of the material is unnecessary. Using 180 amperes and an arc voltage of 60, one-quarter inch boiler plates, butted together without beveling, have been welded at a speed of 60 feet per hour.

Automatic Wire Feeding Device with Attachment for Welding in Hydrogen Atmosphere

Ductility is a factor of prime importance in the welds of structures that are subjected to vibration, accidental bending stress, or overload. Also, ductility equalizes internal cooling stresses when present in the weld. If any part of the ductile weld is stressed beyond its elastic limit, it will not crack. It will yield until the stresses are more or less equalized all along the joint, which is so proportioned as to stand with safety the imposed load. It has also been found that the metal deposited in the hydrogen atmosphere has a higher elastic limit. The elastic limit of pure iron electrodes before deposition averages 29,000 pounds per square inch; the elastic limit of the same electrode deposited by the arc in hydrogen averages 42,000 pounds per square inch.

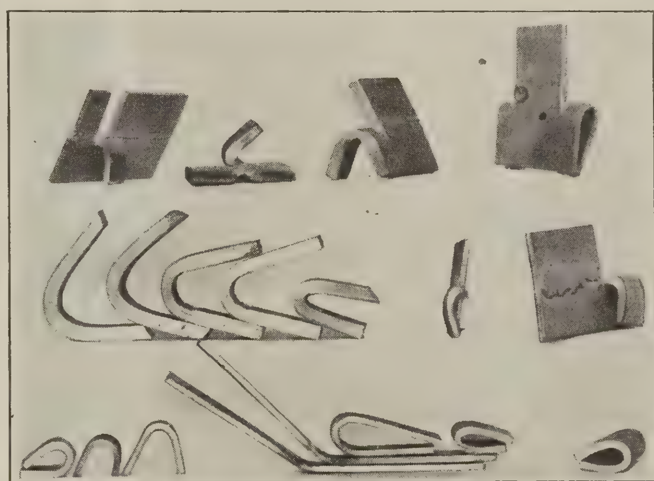
In this welding process the arc is maintained inside of a hydrogen stream which burns along its outer surface of contact with air. The electrode is entirely surrounded by hydrogen, which eliminates the possibility of the metal in the crater coming in contact with air. Direct current is used. The equipment as developed in the laboratory includes the direct-current generator, gas hose, and spool of welding wire mounted as a unit on one base. The welding wire, the hydrogen gas and the electric current are sent through a flexible hose to the torch nozzle.

After the work with the hydrogen atmosphere was found to be successful, experiments with mixtures of hydrogen and carbon monoxide were conducted in accordance with Professor Elihu Thomson's suggestion, and under his personal guidance. Water gas, containing about equal volumes of hydrogen and carbon monoxide, was next tried. It was found that welds produced in such an atmosphere were ductile and easier to produce. Work with various mixtures of carbon monoxide and hydrogen, produced either synthetically or by decomposition of various organic compounds, demonstrated that ductile welds can be produced in the atmosphere of any mixture of the two gases. Methanol or synthetic wood alcohol was found to serve well in this gas, so that transportation with portable outfits is facilitated.

A series of experiments with nitrogen-hydrogen mixtures showed that mixtures of these gases also give ductile welds. The use of liquid anhydrous ammonia which contains one volume of nitrogen and three of hydrogen, in this connection makes it possible to store large quantities of the gas in small volume as a liquid.

Still other gases and methods are being investigated in the Lynn laboratory, and academic studies are being made of the theoretical aspect of welding in different gases.

In its present state the process is being extended to the welding of alloy steels, non-ferrous materials and their alloys. The careful selection of the appropriate gaseous



Samples of Arc Welds Produced with a Semi-Automatic Machine in Hydrogen Atmosphere Bent Without Cracking

mixture determined by the nature of the materials to be welded is an essential factor for successful work.

In brief, this process is a combination of an electric arc which supplies the energy and an appropriate chemical reagent which being in a gaseous state and at extremely high temperature acts almost instantaneously.

"It Didn't Just Happen" is the title of a 32-page pamphlet which has been issued describing the Atlantic paucity of the means of transportation in the southeastern Coast Line Railroad. Starting with a map showing the states in 1850, and a very brief historical sketch, the book describes the building and the operation of a railroad at the present day. The illustrations alone afford a very satisfactory and well-balanced picture of the activities of the construction and operating forces of the Atlantic Coast Line system of 4,924 miles. The text is well written, but severely condensed, the pictures taking up much the larger portion of space. Of the 50 illustrations, the first 25 deal with construction and the remainder with shop work, etc.

Design of An Armature Winding Stand

A Description of a Useful Device in the Train Lighting Repair Shop of the Southern Pacific at West Oakland

By Niels Hansen

Assistant Foreman Electrician, Southern Pacific Ry., Oakland, Cal.

THE armature winding stand pictured below supporting a U. S. L. type M. armature is used to support any of the various types of axle generator armatures or other armatures of about the same size, while undergoing repairs or rewinding.

The principal features of the device are that it is just about the proper height for the average workman to work to best advantage; that the right hand armature support can be quickly moved to the right or left and locked in the desired position so as to accommodate armatures of different lengths; that the stand is portable, being equipped with four double casters and that it has a sheet iron covered table for the workman to place the tools he is working with on, just low enough to not interfere with the projecting armature coils or leads.

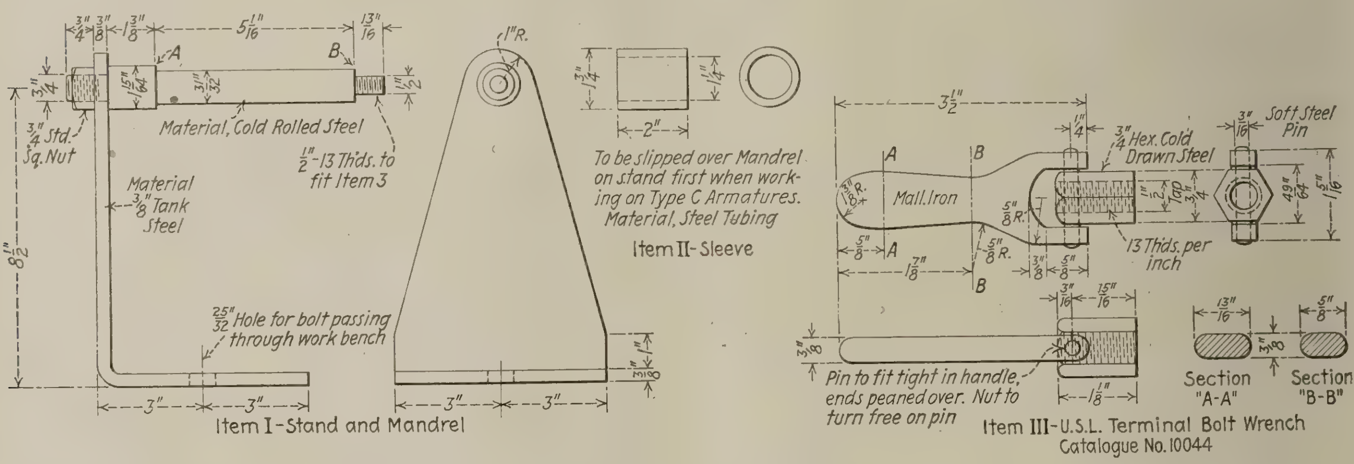
The top of the armature supports stand 44 in. over-all above the floor. The stand is 28 in. long and 24 in. wide at the bottom. The table is 31 in. high, 11¾ in. wide by 28 in. long and covered with a sheet of No. 16 gage galvanized iron. The whole structure is made out of pine 1¾ in. thick. The joints are all mortise and tenon joints glued together thus requiring no angle bracing. The two vertical sides are 6 inches wide except at the bottom where they widen out to 10 inches. The left hand side, extending above the table to form one of the armature supports, is capped with a piece of maple as may be seen in the picture. The right hand side terminates in a joint with the table. The right hand movable armature support *A* is a piece of 1¾ in. by 6 in. by 12½ in. maple bolted upright to the vertical side of a piece of 3/16 in. by 9 in. by 12½ in. tank steel bent at right angles so that the vertical side stands 8 in. high leaving the base 4½ in. by 9 in. Two short pieces of ½ in. by ½ in. square iron are screwed in line to the under side of the base and act as a key by engaging in the slot which can be seen in the picture in the top of the table. An inverted ½ in. bolt passes through the slot in the table and through a 17/32 in. hole in the center of the base between the two ½ in. by ½ in. iron keys. This movable support is then secured by a No. 10044 U. S. L. terminal bolt wrench being screwed on the top or threaded end of the ½ in. bolt. This wrench may be seen in the picture at *B*. The head of the ½ in. bolt slides in a metal guide or channel formed by screwing a strip of ⅛ in. by 1 in. band iron on each edge of the bottom of the slot to prevent the head of the bolt from digging into the wood and then on top of each of these pieces is a strip of ¼ in. by ¾ in. flat iron to keep the bolt from turning. A semi-circular groove 2⅛ in. across and 1 11/16 in. deep is cut in the top of each armature support for the shaft of the armatures to rest in.

The distance between the armature supports can be adjusted from a minimum of 12 in. to a maximum of 22½ in.

The bottom of the stand is equipped with four Payson Manufacturing Company, No. 33 double wheel anti-friction casters making the stand portable. This feature saves a lot of unnecessary handling of armatures. The stand can be shoved to any part of the shop desired for blowing out, testing or painting the armature, etc. The armature therefore, receives a minimum amount of handling.

A little drawer shown in the photograph at *C* is located just below the table to the left. It is 6 in. by 10¼ in. by 2¼ in. deep and can be pulled out from either side of the stand. This is handy for holding small pieces of insulation, wedges, etc., to be used on the job being worked on.

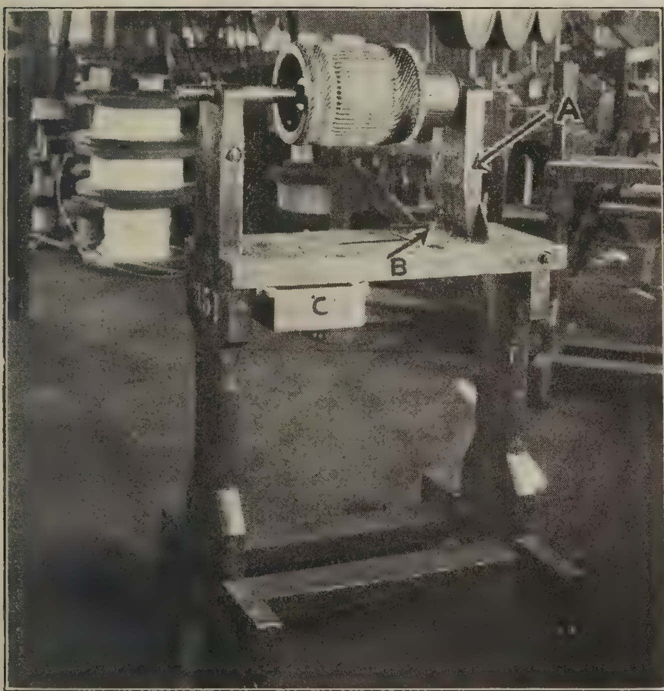
At present the shop is equipped with two winding stands of this type, two others of about the same dimensions, but having both armature supports permanently set 21 in. apart and two others about the same as the latter, but having no casters. It is our intention to replace the last two with new ones similar to the one here pictured and described.



Winding Stand for Pyle National Armatures Type E2 and Type C

For the repairing and rewinding of "Head End" 35 kw. G. E. Company turbo-generator armatures and other large armatures, the shop is equipped with one large winding stand 38 in. high overall, 37 in. long and 36 in. wide at the bottom. The distance between armature supports is 33 in. It is made out of ½ in. by 1¾ in. flat iron with ⅜ in. by 1¼ in. iron cross braces. This stand is portable, being equipped with four double casters similar to the other stands.

The Southern Pacific Company has at present 1085 locomotives equipped with Pyle type E2 turbo-generator



Armature Winding Stand with Adjustable Support

headlight sets, 389 with Pyle type C sets and 178 Pyle type E sets besides about 111 other types including 59 General Electric and 11 Sunbeam sets. Naturally there is a continual flow of these types of armatures passing in the shop for repairs and out again. In order to take care of the repairing of these armatures we have developed a small winding stand which will hold either a type E2 or a type C armature so that it may be repaired or rewound most conveniently. This stand of which we have four in use in the shop at present is illustrated in the drawing Fig. 2, item 1. When used for holding an E2 armature the latter is slipped on to the mandrel against the shoulder *A* which allows the commutator end of the spider to project about 1/16 in. beyond the shoulder *B*. A ½ in. washer and the U. S. L. terminal bolt wrench shown in item 3 are then used to lock the armature in place. When it is desired to work on a Type C armature the sleeve item 2 is first slipped over the mandrel over and beyond shoulder *A*. This allows the end of the spider on the type C armature to project about the same amount beyond shoulder *B* as the type E2 does. The same washer and terminal bolt wrench are again used.

A hole through the base of the stand permits it being bolted to the work benches by means of a ¾ in. machine bolt passing through both with the nut on the top side. The stand can readily be turned around in any direction desired on the armature turned around on the mandrel. The construction is such that there is nothing to interfere with the work of winding on the coils. Flat Deltabeston covered magnet wire size .025 in. by .150 in. is used. The original crimped edges of the commutator slots are sawed away and the slot slightly deepened when the Pyle armatures are rewound. The leads are then thoroughly soldered.

Regenerative Braking for Multiple Unit Trains

By L. M. Aspinwall
Railway Equipment Engineer Westinghouse Electric & Manufacturing Company.

A SCHEME of regenerative braking for use on multiple unit cars has been developed by Westinghouse engineers and equipments are now being tested in actual service on the Chicago Rapid Transit lines. The operation is proving to be very satisfactory.

Regenerating braking has been in use for some years on electric locomotives operating on electrifications where long heavy grades exist. Such applications have been justified by the saving in power, reduction in brake shoe wear and the ease and greater safety of train operation.

In multiple-unit train service the runs are generally comparatively short and the schedule speeds high, with the result that braking is started at high speeds and a large percentage of the energy taken from the line is wasted in heat at the brake shoes. On this account, the application of regenerative braking to service of this character offers possibilities of thoroughly beneficial returns.

Regenerative braking on electric locomotives is a comparatively simple matter, for in this case the usual problem is to maintain a constant speed down a long grade. In the case of multiple-unit trains operating on a high schedule speed with frequent stops, the problem becomes a more difficult one. In this case, it is necessary to be able to start braking instantly at widely varying speeds, to be able to maintain a practically constant rate of braking over a period during which the speed is rapidly falling, and finally, to glide smoothly from regeneration to air braking for the final stop.

The system developed is particularly suitable for two-motor, double-track cars of the type which are common in subway and elevated service. Two axle-driven machines mounted on the trailer axles supply exciting current for the fields of the main motors during the braking period, and act as motors during the period of acceleration. On account of this motoring action during acceleration, these machines are designated as "boosters." The booster armatures are connected in series with the

main motors during acceleration, and their fields are separately excited.

The design and gearing of the axle machines are such that when motoring they add approximately 25 per cent to the tractive effort supplied by the main motors. This additional tractive effort is obtained principally from energy which usually is wasted in resistance so that this is a gain aside from the regenerative feature.

A feature of the system is the use of a constant time element sequence switch for bringing in the correct switches during the braking period and for regulating the field strength of the "booster." The system also embodies means for regulating the regenerative currents, for balancing the generated voltage against the line voltage and for cutting in and out the air brake so that it will act in proper conjunction with the regenerative system.

The regular equipment on the car consists of two Westinghouse type 567-R-1 motors with a gear ratio of 17:60 and Westinghouse automatic electro-pneumatic control. The equipment added for regeneration comprised two "booster" motors, an air-operated sequence switch, four electro-pneumatic switches, two engineer's brake valve switches and several relays. The weight of the added equipment is approximately 4,500 lb. and the total weight of car with the additional equipment is about 79,000 lb. The equipment on this car is so arranged that the master controller and engineer's brake valve are handled in precisely the same manner as in the case of the ordinary non-regenerative equipment. When the master controller handle is thrown to the "full on" position, the acceleration takes place in the usual manner, except that the "boosters" act as motors and assist the main motors to bring the car up to speed. When full parallel position is reached, the "boosters" are automatically cut out of circuit.

When the master controller handle is thrown to the "off" position, the proper connections are automatically established so that the main motor fields are excited by the "boosters" to such a strength that a voltage equal to a little more than line voltage will be generated across the motor armatures. This generated voltage is automatically maintained within fixed limits as the car drifts to lower speeds, so that this "stand by" position is maintained ready to start braking at any instant.

When braking is desired, the engineer's brake valve handle is moved to "service" position and the desired reduction in brake pipe pressure is made in the usual manner. The moving of the brake handle to "service" closes a pair of contacts in an attachment which is mounted on top of the engineer's brake valve in place of the usual handle guard. This action closes the line switches and throws the motors onto the line. At the same moment that the line switches are closed, the fields of the "boosters," which are exciting the main motors, are strengthened by cutting out a certain amount of resistance and the sequence switch which governs these fields starts to revolve at a constant speed.

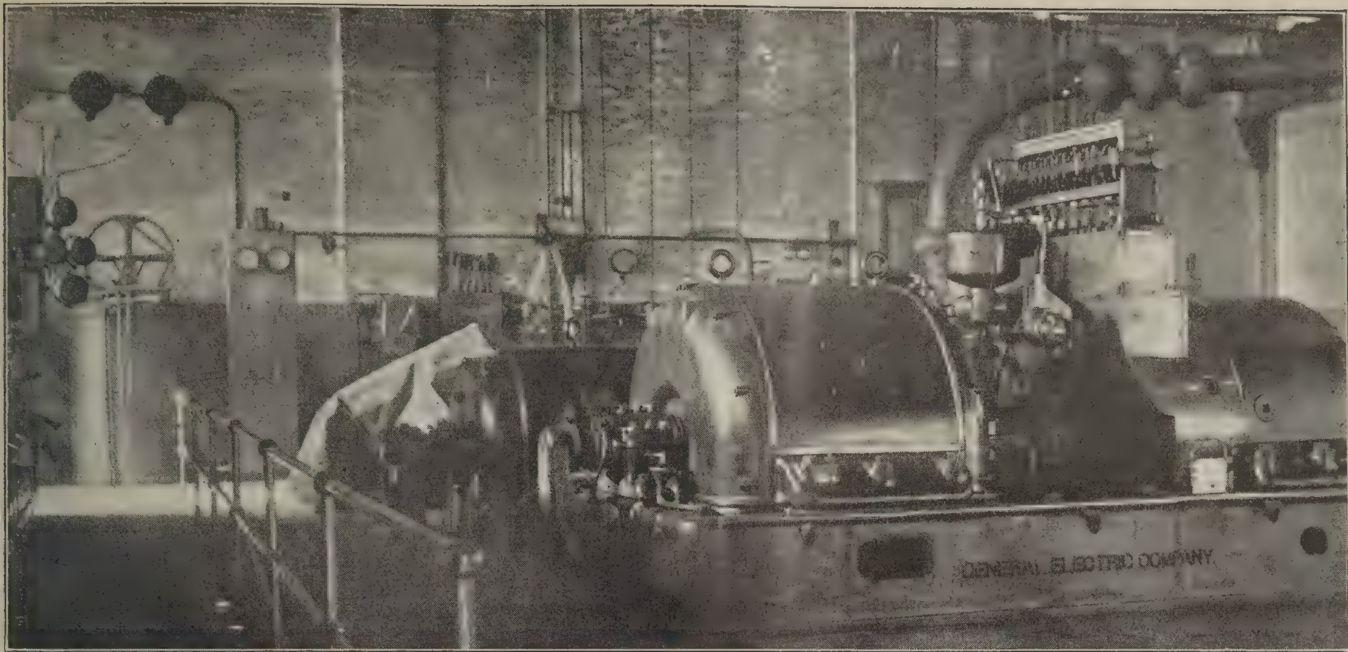
The result of these operations is to start regenerative braking immediately when the handle is moved to "service" position. These take place before the air brake has had time to come into action. The current which is regenerated to the line closes a series relay and blocks off the connection between the brake cylinder and the triple valve so that no air passes to the cylinder in spite of the fact that a reduction has been made in the brake pipe pressure. The sequence switch as it revolves at constant speed gradually cuts out resistance in the "booster" fields and at the same time carries the motor connections through a bridging transition from the parallel to a series combination, with the result that the regenerative braking is maintained at a practically constant rate down to a speed of approximately ten miles an hour. At a speed of approximately 12 miles per hour, the air brake is automatically cut in, and when the pressure in the brake cylinder has reached a given value, the regenerative braking is cut out automatically. The pressure attained in the brake cylinder at this time is governed by the reduction which was made in the brake pipe pressure at the time that regenerative braking was started.

During the tests on the car made on a test track at East Pittsburgh, Pa., the transition from regenerative to air braking was made so smoothly that it was hard to detect when the change took place without watching the instruments which were in circuit. The final spotting of the car is taken care of in the usual way by manipulating the air brake. The connections on the car are such that if regenerative braking fails to act for any reason, the air brake comes into action in the regular way. The emergency or the engineer's brake valve is left intact so that air braking is always obtained on this position.

One of the two cars equipped has received very elaborate laboratory tests and a second car equipped with identical apparatus is being tested under service conditions in typical Chicago Elevated service.

The Great Northern has adopted a plan whereby, with the co-operation of the Pullman Company, the dining, sleeping and observation cars of the Oriental Limited will be remodeled so as to include any new service feature of recent origin. The cars will be sent at regular intervals to the Pullman shops where the new features will be installed. Each of the 10 trains now operated is being furnished with porcelain washbowls.

On the Gotthard Line, Switzerland

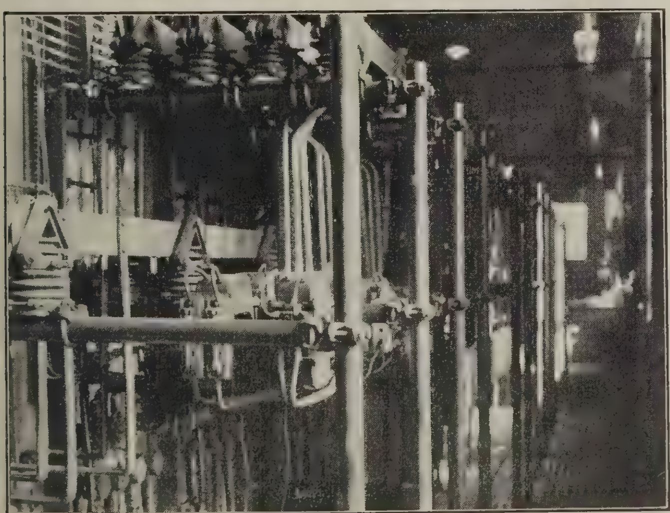


Interior of Power House at Waycross

Atlantic Coast Line Shops at Waycross, Ga.

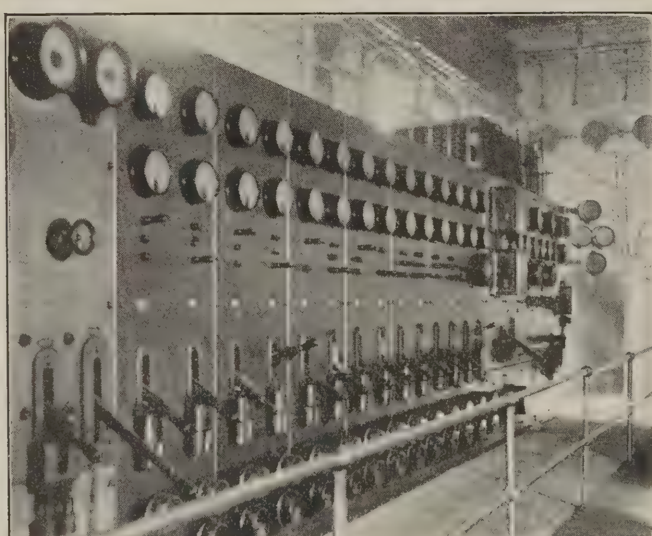
Railroad Company Generates Own Power—Electrical Repair Work Typical of That Done Throughout The System

At Waycross, Ga., the Atlantic Coast Line maintains the largest repair shops on its entire system, although the Emerson shops at South Rocky Mount, N. C., have recently been enlarged and many facilities added which has very greatly increased the importance of this shop. At both places, general overhauling work is done, each having large coach shops and paint shops. While the electrical repair work is divided between the two main shops a description of the methods and practices used at Waycross may be taken as typifying the general practice of the Coast Line in regards to handling of matters pertaining to the electrical department. There are also a number of smaller shops distributed throughout the system at which running repairs are made.



Behind the Switchboard in the Power House

At the smaller shops, electrical energy is purchased, whereas at the two larger shops, at the present time, all electric power is generated. Prior to the time that the shops were electrified, machine tools were driven by line shafting in the so called group drive and at present a considerable number of these tools are still driven in this manner. However, all of the new equipment that has recently been purchased and all that will be acquired



Front of Switchboard Showing A. C. End

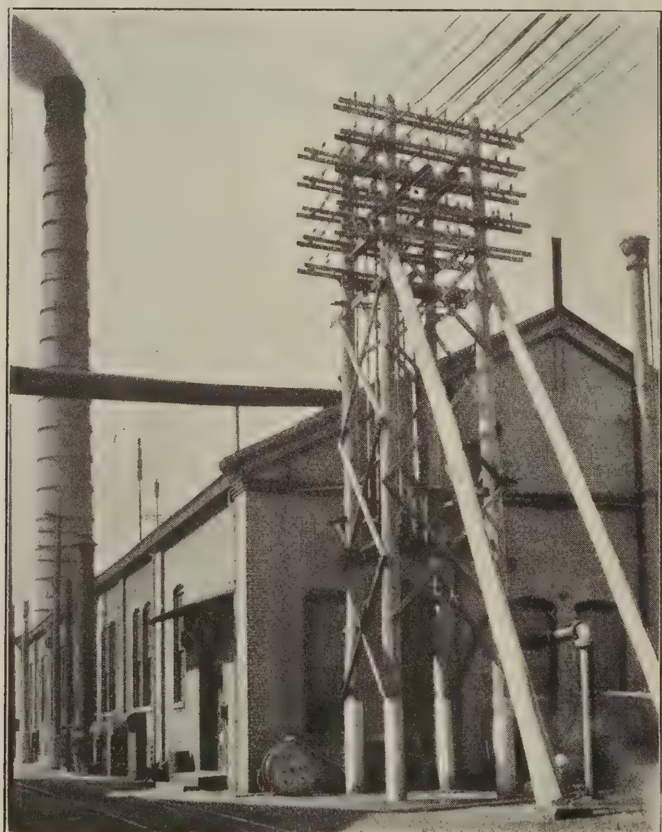
in the future, will where practicable, be direct connected to individual motors.

A number of 100 ft. turntables of the bridge type have been installed on the Coast Line system and these are equipped with two 25 hp. motors each, most of them being 3 phase, 60 cycle, 440 volt. The headlight equipment on the locomotives is of several different types and the capacity of the turbo-generators varies from 500 to 1,000 watts.

Power Supply

Current is generated at Waycross at 2 phase, 440 volt 60 cycle, but recently transformers have been installed which convert this 2 phase into 3 phase and energy is distributed over the same circuits so that both 2 phase and 3 phase motors are driven without the installation of any additional 3 phase lines.

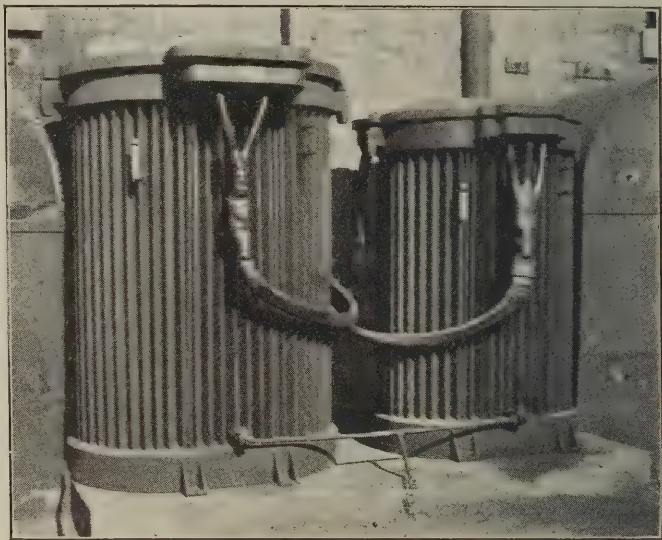
There is in progress at the present time, a gradual



Power House Showing Beginning of Pole Line

changing over from 2 phase to 3 phase operation so that eventually the standard voltage in use throughout the Coast Line system will be 3 phase, 440 volt, 60 cycle. In the meantime, all 2 phase motors that require re-winding are not re-wound for 2 phase operation again, but are provided with 3 phase windings. This gradual change is facilitated by the fact that the four wire distribution system carries both 2 and 3 phase current and both will be available until such time as the change to 3 phase operation is completed.

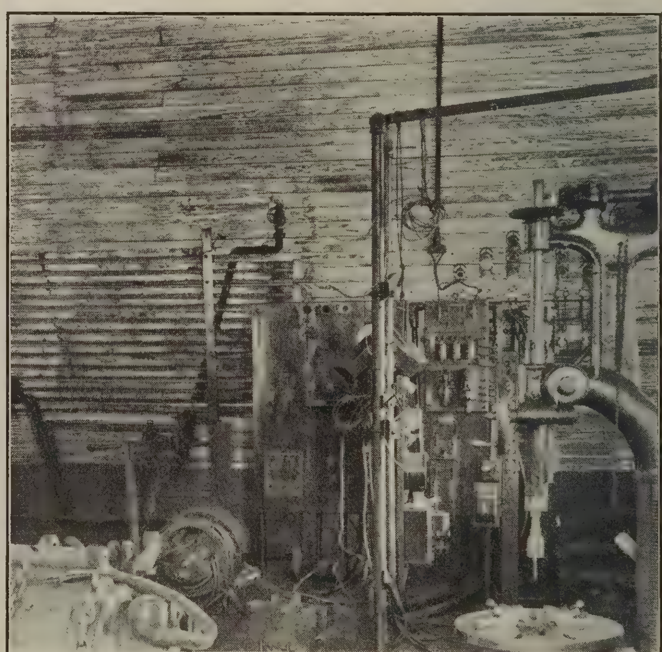
In changing motor windings from 2 phase to 3 phase operation, there is a slight sacrifice in motor capacity, but this is relatively a very small factor as the converted motor will give within approximately 12 per cent of its rated capacity and at the same time, balanced 3 phase operation is secured. In reconnecting motors none of the coils are cut out in the change from 2 phase to 3 phase. If the motor is a 40 degree motor and rewound for 3 phase operation and rated for 50 degree continuous rating, the capacity is effected only about 5 per cent. All calculations with regard to the rewinding of such motors as are



Auto Transformers Are Located Just Outside the Wall of the Power House Back of the Switchboard

changed from time to time is worked out in the office of the electrical engineer.*

An interesting example of what is possible in making radical changes in electrical equipment without interruption to service was furnished about one year ago, when an old switchboard which had been in service since 1909 was replaced by a modern board. The new switchoard



Where Generators Are Put Under Test Similar to Road Conditions

was erected in the same place as the old board but wider spacing was given to the bus-bars. All connections from the underground cable system which has previously supplied current to the shops were changed to the overhead

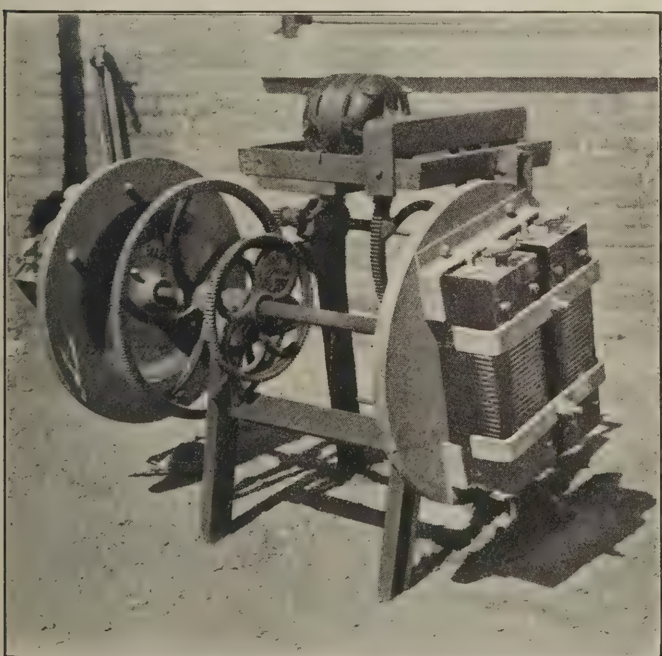
* Complete derivation of equations and formulas for making this change will be published in a subsequent issue of the *Railway Electrical Engineer*.

distribution system. This meant the reconnection of every circuit and every machine and a replacement of the old board with a new one. The entire job was accomplished with everything in running order on overhead lines and new switchboard so rapidly that it was only necessary to shut down the plant for approximately one hour.

Two large auto transformers are located outside the wall of the power house and these are connected by the well known Scott connection so as to give 2 and 3 phase current on the same busbars.

Putting in a New Stator Winding

Such direct current as is used at Waycross is developed by a 450 hp. synchronous motor, driving a 300 kw. d. c. generator. The synchronous motor is a valuable asset in regulating the power factor of the plant as it is possible to make the power factor practically anything desired up to approximately 95 per cent by merely adjusting the field of the motor.



The Unique Battery Shaking Device Is Driven by the ¼ Horsepower Motor Mounted at the Top

The overhead distribution system was necessitated by trouble which developed in underground circuits due to low land and ever present water. The pole line which carries the conductors from the power house to the various shops is about 50 ft. above the ground.

Six boilers, 250 hp. each of the Heinie water tube type, during the last year have been raised 4 ft. and Dutch ovens have been installed. Shavings from the planing mill are fed directly into 3 or 4 of these while coal is used for the others.

An ash handling steam jet system has recently been installed. During the last year or two, reinforced steel concrete 500-ton coal chutes using skip hoists have been installed at many of the Coast Line points. In addition to Waycross such chutes have been built at Petersburg, Va., Rocky Mount, N. C., Fayetteville, N. C., Charleston, S. C., Jacksonville, Fla., and Montcrief, Fla.

Power is generated at 440 volt a. c. and stepped up to 2200 or 2300 volts for transmission to a number of buildings which are located some distance from the plant, and then stepped down again to 220 volt for lighting. Among the buildings supplied by this line are the pas-

New Motor Repair Shop Nearing Completion

Electrical Repair Facilities

The electrical repair shop at Waycross is equipped with suitable apparatus for doing all of the repair work for the second and third divisions. The armature winding room has an up-to-date coil winding machine and forming and taping machines. With this equipment the shop is able to do practically any kind of winding work that is likely to be required of it.

A large 16 in. swing back lathe with 8 ft. bed, is an important machine in the shop as it eliminates the necessity of carrying many small jobs to the machine shop and thus facilitates the work.

For testing purposes, a set of auto transformers supply different voltages and practically any voltage from 50 to 440 volts is obtainable for single, 2 or 3 phase testing.

At the present time, an addition is being built to the repair shops which will be used as a new motor repair room. It will have a number of facilities which have not been available in the old shop and among these is an overhead crane. In one end of the building there will be located a large door through which it will be possible for

the store house truck to pass and thus deliver the material directly to the room. An electric oven will also form a part of the equipment of the room. There is also planned an up-to-date impregnating tank in the new room and it is expected that better varnishing will be accomplished.

Car Lighting Work

The facilities of the shop are such that car lighting maintenance work is carried on very satisfactorily. All of the axle light equipment of the Coast Line is 30 volt and at the present time there are about 280 steel cars supplied with this equipment. It is expected that this number will be increased by 73 in the near future.

Edison batteries are used exclusively and major repairs to these cells are not undertaken, but when such work is necessary the batteries are sent to the Atlanta works of the Edison Storage Battery Supply Company. Cleaning and such ordinary attention as car lighting batteries require is given at Waycross.

The maintenance practice is to remove generators, regulators and batteries from each car shopped. The regulators are given a complete overhauling as well as the generators. The batteries are removed from the trays and each cell is thoroughly cleaned and painted with Esbalite paint. The trays are also cleaned and painted and the batteries reassembled. This practice has been followed at Waycross as it is believed that it is superior to dipping.

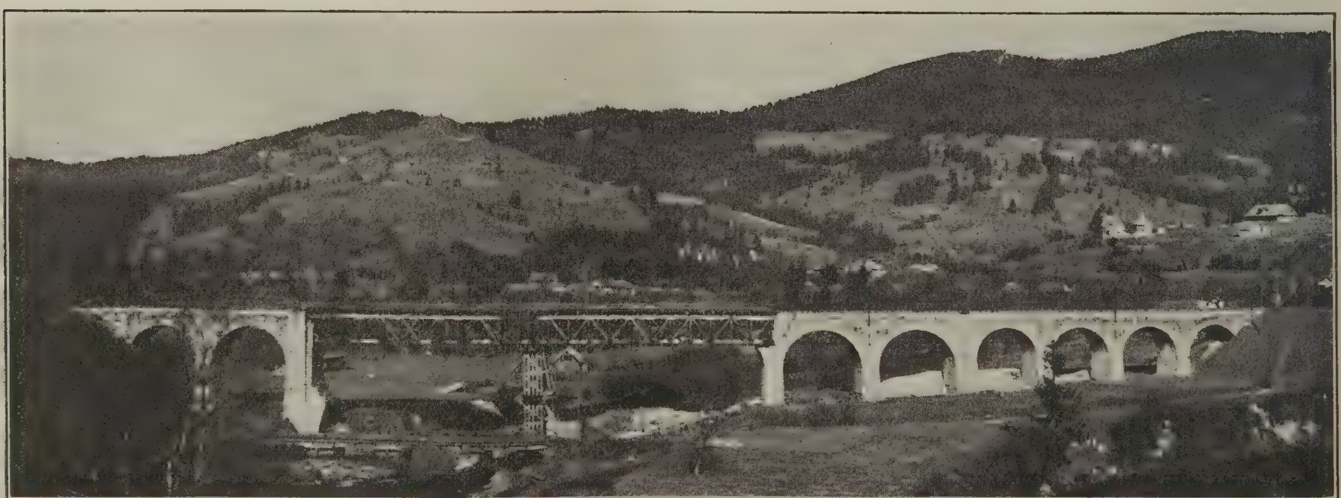
After all of the parts have been overhauled they are tested on a test rack. The regulators are connected and given a complete running test under as near working conditions as is possible to secure in the shop. During this test all parts of the equipment are closely watched and much of the trouble that would probably occur under operating conditions is found at this time and corrected.

The generators are run for at least 8 hours on the test rack and during this time the regulators are also being tested with the batteries, and adjustments are all made on a lamp bank which gives the same load as a car for which this equipment is used. The type of car lighting equipment used on the Coast Line is varied and practically all of the different makes are represented.

Ampere hour meters are also set up on a test rack where they are tested, cleaned and adjusted.

A novel shaker for Edison batteries has been developed by the car lighting department. In using this device the batteries are discharged to a point where they can be safely short circuited. The cells are mounted on either side of the machine and a ¼ hp. motor starter which causes the batteries to rotate at about 10 revolutions per minute. Each cell receives one hour of this treatment and the capacity of the machine is such that four cells of the A-8-H-W type can be shaken at one time. Smaller cells of the A-4-H type can be handled 8 at a time. After the shaking process has been completed, the solution is poured out in a carboy and is allowed to settle over night. The clear liquid is then put back into the cells which are rinsed for 30 minutes, after which new solution is added. The battery is then ready for charge. Nothing but distilled water is ever used in flushing Edison batteries at Waycross and an excellent still has been constructed in which the water is heated by steam coils. The still has a capacity of about 10 gallons per hour. One of the latest developments in the car lighting department at Waycross is the converting of branch line cars from oil to electric light. A number of these cars have recently been equipped with four or five 50-watt lamps, depending upon the length of the car. These lamps will be lighted from headlight generators of 1000 to 1500-watt capacity. Baggage cars which have been converted in this manner use only three 50-watt lamps.

Where Scrap Is Handled by Yard Crane—220 Volt D. C. Is Available For Use With Electric Magnet When Desired



Temporary Reconstruction of Stone Arch Bridge Damaged in War, Polish State Railways

Electrical Repair Shop of the Boston and Maine

Practically All Repair Work for Road Excepting Electric Locomotives is Done at North Billerica Shops

IN the electrical repair shop of the Boston & Maine located at North Billerica, Mass., practically all of the electrical machines used on the road, with the exception of electric locomotives are repaired. The work done includes headlight generators, car lighting generators, shop motors, welding machines, crane motors and miscellaneous jobs such as crane brake coils, lifting magnets, etc.

The work is done in a shop about 40 feet square, by four

Fig. 1. Repair Bench and Armature Stand

armature winders and one helper. In addition to these men there are eight electricians and eight helpers employed in the North Billerica shops, but their work consists of electric locomotive, car lighting, locomotive headlight maintenance and the maintenance of shop power and light service and does not include armature winding and machine repair.

Shop Equipment

The repair shop is equipped with two coil winding machines, one taping machine, a small lathe, a small planer with a bed 12 in. wide by 24 in. long which is used for planing contacts, etc., one slot insulation cutter, a number of meters, a megger, a portable transformer for making high potential tests up to 11,000 volts, a dipping tank, a baking oven, several winding stands, benches, vices, testing stands racks and shelves for wire and insulation, scales for weighing wire, a four-wheel truck for carrying motors, etc., and a large square box for scrap.

The dipping tank is cylindrical in shape and has a hinged cover. It is kept about three quarters full with 60 gallons of Westinghouse No. 335 insulating varnish and the varnish is kept at a specific gravity of .85 by addition of a little gasoline from time to time. Heavy parts such as armatures are dipped with the aid of a small chain hoist.

The baking oven is six feet wide, six feet high and eight feet long. It is kept at a temperature of 225 deg. F. by 550-volt electric heating units. Temperature control is effected by manually switching on or off some of the heating units.

Special low benches are used for much of the work that is done. These are 26 in. high, 20 in. wide and 6 ft. long. This height permits the worker to sit on a stool or chair of ordinary height and work comfortably on an armature supported in a small armature stand placed in the bench. Such a bench and stand are shown in Fig. 1. In the foreground on the bench in this same illustration is shown one of the wnider's hammers. It is an ordinary ball peen hammer, the ball of which has been wound with a thick layer or winding of friction tape. The armature on the stand is a car lighting armature and at the far end of the bench is a crane brake magnet coil spool. Before the spool

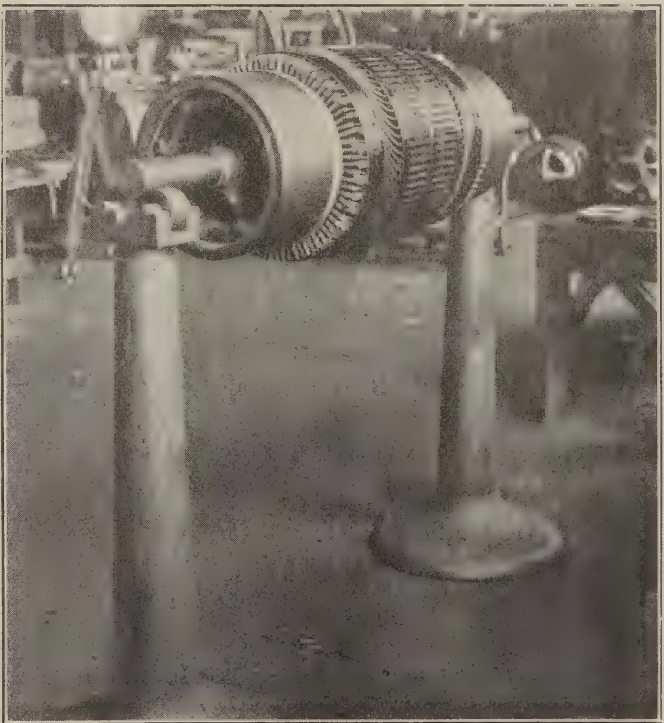


Fig. 2. Floor Stands Are Used for Large Armatures

is wound it is insulated with varnished cambric applied to the spool with thick shellac used as glue. In the background of Fig. 1 may be seen the front of the baking oven.

Floor stands are used for supporting large armatures undergoing repairs. An armature taken from a welding generator is shown in Fig. 2 supported on two such stands. The special roller arrangement shown at the top of the stand under the armature shaft makes it easy for the winder to turn the heavy armature while he is working on it.

The winding shop is served by an overhead monorail

hoist which extends out into the balcony machine bay where the commutator turning is done. At the right in Fig. 3 is shown the insulation cutter and at the left the scrap box. When this box is full it is picked up by the monorail hoist and carried out.

Methods

Coils for all standard machines are wound on forms on the two winding machines shown at the right in Fig. 4. The necessary tension for winding is obtained by running the wire between two fibre blocks held together with bolts. The taping machine is also shown in Fig. 4 back and at the left of the winding machines.

Coils which were made up originally with double cotton covered wire are rewound with enameled single cotton covered wire. This usually makes the coil somewhat smaller than it was originally but is a distinct advantage as it is never necessary to force in an oversized coil by hammering. If the rewound coil is so small as to be loose, the fit is made snug by putting in more slot insulation.

A few old types of machines have to be wound by hand. Direct current machines such as welding generators which have to stand high temperatures, have coil terminals soldered to commutator risers with solder which is 90 per cent tin and 10 per cent lead. The risers are swedged into slots in the commutator bars. Fifty-fifty solder which is half lead and half tin is used for all ordinary soldering work as it is easier to apply.

When banding wire is applied to an armature, the banding wire is tensioned with a fibre clamp while the armature is turned by means of a piece of pipe fastened to the shaft with a lathe dog.

Commutators are turned by a man especially skilled in

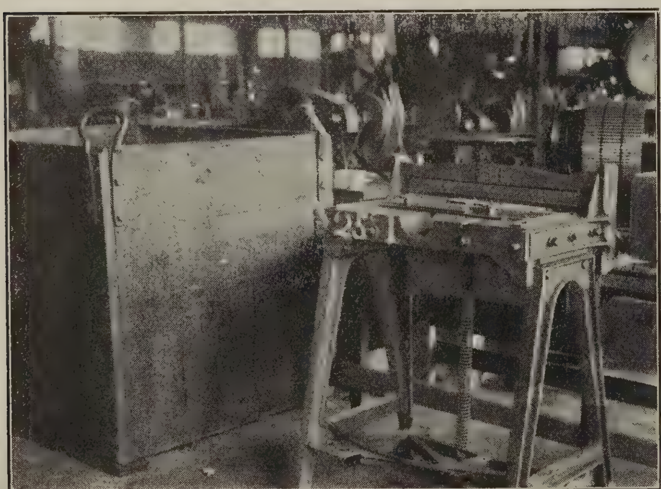


Fig. 3. Scrap Box and Insulation Cutter

this work. The work requires high turning speed, slow feed and a pointed tool with proper rake and clearance. Only as small an amount of copper as possible should be taken off.

All headlight commutators are undercut. Others are not undercut unless the mica does not wear down properly.

The ring armatures of headlight generators must, of course, be wound by hand. When it is necessary to repair the armature, the coil terminals which are swedged into the commutator segments are driven out with a punch or screw driver. If the coil terminals are to be replaced, they must first be annealed with a torch. If a terminal should be broken off it is necessary to put in a new coil. When an armature is to be completely rewound, sheet insulation is placed in the coil slots, on the inside of the laminations and on each side of the spider. The slot insulation is held in place with wooden plugs until the first turn of wire secures it in place. The slot insulation is trimmed to proper size with a knife against the wooden slot plug before the winding is started. As each turn of the winding is applied it is held in place with a small tapered plug while the next one is being applied.

The bench at which the headlight work is done is shown

Fig. 4. One Taping Machine and Two Winding Machines Are Used

in Fig. 5. The inverted L shaped stand at the left is used to hold the armatures while they are being wound. It is made of two pieces of conduit, a floor flange and an L-B condulet. The horizontal piece of conduit slips loosely into the armature shaft hole and the outer end of the horizontal piece is split with a hack saw cut so that when a wedge is tapped into the cut, the armature is made tight on the conduit and will not turn. Headlight armature testing equipment is shown at the right in Fig. 5.

Testing

No attempt is made to provide for running tests. The principal reason for this is that most of the shop motors which come in are 60 cycle machines and the Billerica shops are equipped with 25-cycle power. Special care is taken, however, to make complete and effective tests by other means.

During the progress of winding the winder uses 220-volt current with a lamp in series to try for connections, shorts and grounds.

After a direct current armature is wound, current is put through it at points either 90 or 180 degrees apart on the commutator and bar to bar voltage is measured. A special jig for this purpose is used in testing headlight generator armatures. The jig which is shown in Fig. 5 consists of a base with two uprights. The armature shaft is dropped into notches in the uprights and when in this position a spring brass brush touches each side of the commutator. Current from the shop supply is run through the armature by means of the brushes, the amount of the current being limited to 1/4 ampere by having a lamp connected in series in the circuit. A milli-voltmeter is connected to the

brushes to measure the drop through the armature winding. The armature is turned from bar to bar and if the reading in each case is the same the winder knows his work is properly done. The actual reading on the metor will be from 35 to 40 milli-volts depending on the lamp resistance and the shop voltage and if one of the coils should have one too many or one too few turns this test will show it.

When a job is finished it is first tested with a megger.

Fig. 5. Bench Equipped for Winding and Testing Headlight Generator Armatures

If the megger shows a resistance of from 75 megohms to infinity, it is considered O. K. If the resistance is less than 75 megohms it is assumed that there is moisture in the windings or that the enamel is not baked enough. The job is then returned to the oven and rebaked. If the insulation is still low after the second baking the high potential transformer is used to break down the weak point and show its location.

Gas-Electric Drive for Motor Buses*

WITH the present rapid expansion of motor buses in the transportation field, traffic conditions demand a vehicle of large seating capacity which materially increases the weight and this in turn requires more engine power.

The internal combustion engine has been brought to a degree of perfection where its reliability need be no longer in question, but to best utilize its torque characteristics it is necessary to provide for changing the torque ratio between the engine shaft and the driving wheels. It is for this reason that some method of changeable gear reduction is in almost universal use.

Briefly described, the electric drive equipment for motor buses includes a direct current generator which is connected to an internal combustion engine and which supplies current to direct current series motors of a type common to electric railways. Electric reversing and series parallel switches provide for directional movement and customary motor combinations and variation in speed and torque of the driving wheels is smoothly accomplished throughout the entire range by simply wearing the voltage of the generator.

This may be done by manual control of generator excitation or may be obtained automatically by designing the generator with a drooping characteristic so that the voltage will vary inversely with the current demand. By manual method the electric controller must be operated as well as the throttle of the engine. By the automatic method, the control is entirely by means of the engine throttle.

By far the majority of electric drive motor bus operations made in this country are of the automatic type using a drooping generator characteristic with control of the bus speed by means of the engine throttle.

Several factors contribute to the ability of electric drive to maintain higher average speed and frequent stop service. Of chief importance is the elimination of the time lost in safety gears during each acceleration or on grades. This higher rate of acceleration permits higher scheduled speeds. This gain in scheduled speeds means that the electric drive will produce more miles for an hour of the driver's time and effects the material reduction in one of the largest single factors of operating costs, that is, the crew wage.

Discussion

The paper was discussed by representatives of a number of transportation companies which use buses equipped with gas-electric drive and by representatives of manufacturers, all of whom agreed in the main with the speaker.

Railway Passing Through 1000-Year-Old Moorish Arch Near Algeciras, Spain

* Abstract from a paper presented before the New York Railroad Club by H. L. Andrews, assistant engineer, General Electric Company.

Slotting Improves Commutator Operation*

Operating Conditions Determine Best Method of Undercutting Proper Selection of Brushes Important

COMMUTATOR slotting, or undercutting, has been fast gaining in popularity among operating engineers during the past few years. Slotting is cutting or grooving the mica lying between the commutator segments below the surface of the copper so as to allow only copper to come into contact with the brushes. Formerly methods were more or less haphazard, and in many cases the results hoped for were negative and troubles that were intended to be eliminated were multiplied. This, in many instances, resulted in turning the operator against

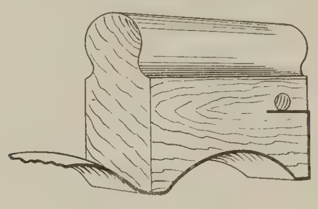


Fig. 1 Sandpaper Block

the whole idea of slotting, and it is still dwelt upon by some as an indictment against all slotting.

Later experience and practice have proved that the operation of any commutating-type machine can be improved by using a method of undercutting applicable to the type of the individual machine and its operating conditions, together with the selection of the correct grade of brush material and the correct application of the brushes to the commutator. Some of the many benefits to be derived from proper slotting and brush selection may be enumerated as follows:

Decreased Commutator Wear.—On slotted commutator brushes with no abrasive characteristics can be used while on flush mica commutators it is necessary to use a

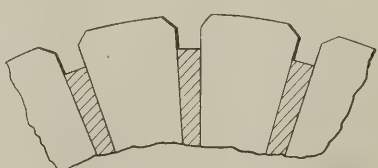


Fig. 2 Square Bottom Slots

brush material having a degree of abrasive action sufficient to keep the harder mica flush with the copper.

Increased Brush Life.—As it is not necessary to use abrasive brushes on undercut commutators, it is possible to obtain a much better polish both on the surface of the commutator and on the face of the brushes.

Decrease (if Not Elimination of) Glowing of Brushes, Sparking, Ring Fire and Commutator Surface Burns.—The most common cause of these conditions is high mica, which slotting abolishes.

Reduction of Frictional Losses.—Frictional and abrasive characteristics of brush material are closely related, and the use of a brush having no abrasive characteristics means also a material of minimum friction. Reduction of this loss from friction has in many cases amounted to 1½ percent to 2 percent of the total output of the machine, and it is directly reflected in the coal bill.

Decrease in Operating Temperature Under Set Load Conditions.—All brush friction is transformed into heat energy at the brush face; therefore, by reducing the friction to a minimum the heat due to friction is also reduced to a minimum.

Increase in Allowable Load.—Two factors contribute to this result, (1) reduction in heat due to friction, and (2) the fact that non-abrasive brush materials almost always have a lower specific resistance, which reduces the heat due to current flow.

Decreased tendency to Develop Flat Spots.—Sparking and burning are reduced, and these are the most common causes of the development of flat spots.

There are several methods of undercutting in general use, some of which are excellent and others of questionable value. Machines and tools of various kinds for undercutting are on the market, and all have their advantages

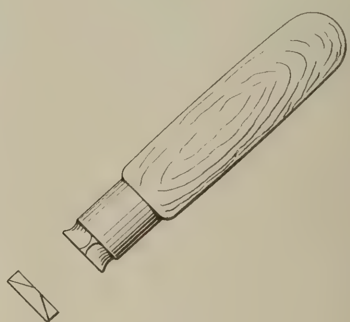


Fig. 3 Beveling Tool

for certain classes of work. Machine tools for this work are usually circular-milling saws operated by some convenient power method. Hand tools are of various types, including holders for pieces of hack-saw blades, shaped raking cutters, files and other implements. Of the hand tools, the curved file with the offset handle has proved to give best results under average industrial operating conditions.

In all cases where the job of slotting is to be done the following general rules apply:

Be sure that the commutator is round and free from flat spots, that there is no eccentricity, and that there are no grooves around the commutators. If any of these conditions exist, the commutator should first be trued up by grinding or turning.

After the slotting job is completed a careful inspection should be made to make sure that no particle of mica has been left flush with the bars, as this always defeats the purpose of undercutting. After this the commutator surface should be polished. This can best be done by a very fine grit commutator stone. If a commutator stone is not available, very fine sandpaper can be used. Before using sandpaper, the coarser grit should be worn off by drawing over a piece of steel a few times. Best results from sand-

* From a Bulletin Published by the National Carbon Co.

paper can be obtained by backing up with a wooden block cut to the curvature of the commutator. A satisfactory method of anchoring sandpaper to such a block is shown in Fig. 1.

As there are various methods of slotting, conditions of operation determine the best method for any particular job. These methods are divided into three general classifications—square-bottom slotting, "V" slotting and arc slotting, of which the "V" type has the widest range of application.

In the following paragraphs the poorest of operating conditions have been assumed, and under good operating conditions figures for minimum peripheral speeds at which slots will clear will be considerably reduced. Commutator diameters have not been taken into consideration, figures being based on the average diameter of commutators found in the average industrial equipment. Small-diameter commutators will clear at somewhat lower peripheral speeds than those of larger size. However, if figures given are followed in practice, satisfactory results will be obtained, as errors are on the side of safety.

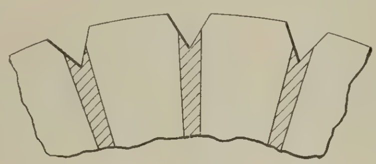


Fig. 4 V-Slots

Square-Bottom Slots.—The square-bottom type of slot is adapted to high speeds only. This slot is usually put in by the use of power-driven milling saws or hack-saw blades. It has been found that the maximum depth of this style of slot that will positively clear itself is 3/64 in., and it is then positive in its action only at peripheral speeds of 5,000 ft. per minute or greater. This practically limits the use of the 3/64 in.-deep square-bottom slot to turbine-driven commutating machines and some 60-cycle rotary converters. The square-bottom slot of 1/32 in. depth is positive in its clearing action at peripheral speeds of 3,500 ft. per minute or greater and can be used to advantage on many larger generators and rotary converters having a commutator speed above this figure.

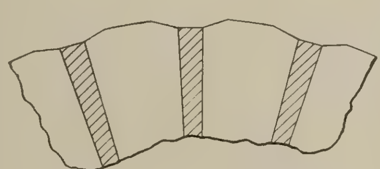


Fig. 5 Arc Undercutting

In the machining of the square-bottom slot there are several details which may seem of minor importance, but careful attention to them is absolutely essential if best results are to be obtained, and they cannot be emphasized too much. Where the power-driven milling saw is used it is impossible to prevent it from coming in contact with the sides of the bars, and wherever this occurs some of the copper is cut or dragged off. Usually the dragging or tearing action is pronounced. This has the effect of cold-drawing on the side of the bar, which causes a hardening of the copper at the side of the slot, and no matter how carefully the surface of the commutator may be smoothed or polished after slotting, there is a knife edge of hardened copper at the edges of each bar. This hardened knife edge will not wear down uniformly with the softer center of the bar and after a time will have a tendency to start flat spots in the center of the bars. This causes the bar edges to run high and act as scrapers against the brush face, shortens the brush life and causes an excess of carbon dust which, in the end, may result in flashovers and the breakdown of the machine. With such possibilities it is, therefore, advisable always to bevel the edge of the commutator bars as indicated in Fig. 2. A bevel surface of approximately 1/64 in. is sufficient for this purpose. Beveling can be accomplished by the use of an ordinary three-corner slim-taper file or with a sharp cutting edge such as a strong pocket knife or a special tool like that shown in Fig. 3.

It is a proved fact that the number of car-miles per motor failure obtained on one interurban railway line in the Southwest was increased more than 30 percent by beveling the edges of the bars where square-bottom slots were used.

V Slots—As has been previously stated the V slot (Fig. 4) has a wider range of application than any of the other types and in time is bound to be accepted as the standard method of slotting for all machines operating under average industrial conditions. At the present time there are no power-driven tools on the market for slotting in this manner, and this makes necessary the use of hand tools to get the results desired. Hand tools are comparatively slow, and many operators, while admitting the advisability of using the V slot, continue to use a square-bottom type solely because of the time saving of power machinery. It is, however, a fact that the improvement to be gained in operation will often pay many times over for the difference in labor cost of putting in the V slot. A V slot of 60-deg. angle, the bottom being slightly rounded, cut to a depth that will bevel the copper to about 1/64 in. at the sides of the slots, will clear itself at peripheral speeds of 1,200 ft. per minute or greater. A careful check of surveys made covering thousands of motors and generators in many industrial and central-station plants shows approximately 76 per cent of the machines operating with a commutator speed in feet per minute greater than 1,200 and less than 3,500 which is the minimum limit for square-bottom slots.

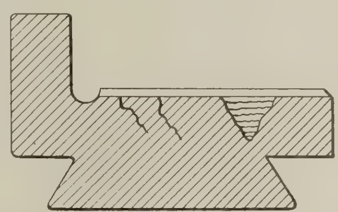


Fig. 6 Scraping Cutter Cracks Mica

Arc Undercutting.—While entirely satisfactory on any machine and under all conditions on account of the cost of properly machining, arc undercutting (Fig. 5) is limited in application to those machines that will not operate satisfactorily when slotted by any other method. When properly machined there is no minimum speed limit at which arc undercutting will not clean, even when the machine is operating under the most adverse of conditions such as engine exhaust, steam water or oil splash. To get these results, however, it is absolutely necessary that slot

machining be held within very close limits. Careful observation of several cases where this method has been used to overcome commutation faults has established 0.010 in. as a maximum depth of under-cutting at which cleaning action is positive at very slow speeds. Moreover, the total width of the slot at the top should not be less than two and one-half times nor more than three and one-half times the thickness of the mica.

There is one method of machining slots occasionally used which very often is the primary cause of serious machine trouble. This is the use of raking-type cutters, whether used by hand or in the tool rest of a lathe. Mica is hard and brittle, and the use of any raking or scraping cutter having a single cutting point is almost sure to cause small cracks or checks in the mica at the bottom of the slots, as indicated in Fig. 6. Where any oil or moisture is present it finds its way into these small cracks and breaks down the insulation between bars, often causing the mica to char and burn all the way to the spider or shaft, thus bringing about complete machine failure and an expensive repair job.

The different methods of slotting recommended above will always prove satisfactory when properly applied to machines in continuous operation. Very often, however, on machines used intermittently, where oil creeps from the bearings, or the atmosphere is moist, oily or dirty, or corrosive fumes are present, failures directly traceable to the slotting develop. Where conditions such as those described occur this trouble can be eliminated by coating or filling the slots with a good grade of shellac, certain air-drying insulating varnishes or some of the commutator cements sold for that purpose. Care should be used in the selection of this material. It must have good adhesive properties. It must dry hard and not gum, but it must not become harder than the copper commutator bars. It must not be affected by oil or moisture and it must be free from abrasive qualities.

With a slotting job properly done, the selection of the grade of brush material to be used on the commutator is of the utmost importance. The brush that gave satisfactory service on the machine while operating with flush mica will not operate correctly after undercutting. Brush material on flush mica commutators must have a degree of abrasive action, which on undercut commutators would be expended entirely in cutting out the softer copper, resulting in greater commutator wear than before undercutting. This would mean more copper dust and a correspondingly greater possibility of failure in insulation, with the consequent breakdown of the machine.

With the proper grade of brush material selected, the application of that grade to the machine becomes of prime importance. Brush angle, brush pressure, brush staggering and fitting of brushes to the commutator should all receive consideration. Brushes with low friction should be more nearly radial than those having high abrasive characteristics. Brush pressure on slotted commutators should usually be somewhat less than where abrasive brushes are used on flush mica. Staggering should be by pairs of studs instead of by single studs. New brushes never exactly fit the commutator and in order to get the proper contact they should be sandpapered in by pulling the sandpaper in the direction of rotation of the commutator.

With correct slotting, the correct brush applied in the proper way, the machine should operate quietly, without chatter, spark, squeal or burn. No lubricant should ever be used on slotted commutators, and if everything is correct it will not be needed.

Bonds and Grounds for Illinois Central Electrification*

ALL tracks for the Illinois Central terminal electrification at Chicago are laid with 90-lb. A. R. A. type rail with a special reinforced angle bar. In addition to bonding all electrified tracks, it is necessary to bond additional tracks between 69th street and 16th street to get the required return conductivity. This makes a total of 131.7 main track miles.

A single 4/0 127 strand soft drawn copper cable bond of the flame-weld type is being installed on each standard joint. This bond has two copper terminals which act to service the cable and provide shoulders for welding. The weld is actually between the outside ball of the rail and the ends of copper strands, but also includes the copper terminals. When straight, it is 13½ in. over all with 8½ in. between terminals and is formed so that it is approximately 7 in. between the inside ends of the terminals. These measurements permit the small loop to extend over the angle far shoulder with the rail joint open the maximum amount.

Special bonds for turnouts, slip switches and movable point frogs are made from 300,000 c.m. 127 strand soft drawn bare copper cable cut in the field to proper length. As these are made as the work precedes it is necessary that they be equipped with special terminals applied in the field with tools and dies developed for the purpose.

The same method and the same cable are being used in making connections from the impedance bonds to rails. Lugs are provided on the impedance bonds for rail connections and also for the cross bonds between tracks and from impedance bonds to negative busses in the structure manholes. Cross bonds are applied at alternate impedance bonds.

For safety reasons all catenary structures must be grounded. The usual practice is to ground to the nearest rail, but on account of the signal track circuits this could not be done. A scheme which promises to be satisfactory has been worked out to bond to a limited number of rails in any particular track circuit and whenever possible to the neutral of impedance bonds.

A flame weld bond is made to the structure and to the ball of rail with a No. 1, 37 strand, parkway cable, the copper terminals being applied in the field as with the special traction bonds. The impedance bonds are also supplied with lugs for the ground connections to structures.

* Abstract of a paper presented before the Western Society of Engineers by W. M. Vandersluis, electrical engineer, Chicago Terminal Improvements, Illinois Central, Chicago.

Office Building and Substation

Southern Increases Use of Electrical Energy

New Buildings Recently Constructed in Atlanta Forecast More Extensive Use for Purchased Power

THE shops of the Southern Railway at Atlanta, Ga., have recently been enlarged and with the increased shop capacity the utilization of electrical energy has been likewise considerably increased.

For the greater part, electrical power is purchased and it is brought to the company's property at 19,000 volts, three phase, 60 cycles entering a small substation located at the property's line. The power is stepped down to 220 volts through a bank of three 250 kva. Westinghouse transformers.

Within the substation are erected two switchboards, one in front of the other, the space between the boards being about four feet. The board in the rear carries all of the oil switches which individually disconnect each circuit, while upon the board in the front are mounted the various control handles for the operation of these switches, the connection between the two being effected by a system of rods and cranks. The board in the front also carries all of the meters used for power indication. Transformers are of the outdoor type so that the actual transformation takes place outside of the building and the current is brought in on large copper bus bars.

From the oil switches, energy is fed into several cables and goes to different buildings. These cables are lead covered and run in underground fibre duct lines, reinforced with concrete. The power requirements are such that six lead covered cables composed of three conductors each of 500,000 circular mills go directly to the erecting shop which is located in the new buildings. Two of the other cables of three conductors each, with 500,000 circular mill capacity brings energy to the old shops.

At the shop ends of these cables are located "Bull Dog" safety switches and from these the current is taken to the various lighting and power panels of Crouse-Hinds make, conveniently located throughout the shop. There are no exposed wires or bus bars anywhere in the new buildings.

The wiring in the old buildings which has been in service for many years, is open work construction and this is now being replaced with new wiring all of which is being put in conduit.

It may be of interest to note just why the Southern has adopted a 220 volt system as a standard in the Atlanta shops. Many years ago, when electrical applications were comparatively few, the Southern started out with one 15-hp., 220-volt motor on a turntable. Gradually more 220-volt equipment was purchased so that when the time came to make a decided increase in power, such as was necessitated by the erection of the new shops, so much 220-volt apparatus was in service that it did not seem practical to change over this system.

A small amount of direct current power is generated by a Westinghouse engine which has been in service for many years. At the present time this d.c. is used to operate a 110-volt motor on the transfer table as well as to furnish current for some of the lighting in proportion of the shop. For the greater part of the old building, however, the lighting is supplied from a 15 kva. 230-115 volt transformer which is fed by a two conductor No. 0 varnished cambric, lead covered cable.

Cranes

A number of cranes of the Pauling & Harnischfeger make are in service in the shop and yard. There are two 200-ton cranes, which are the largest in use on the system, in the new buildings. The next largest crane is located at Birmingham, Ala., and this has a capacity of

150 tons. These cranes were equipped with 125 hp. motors both on the bridge and hoist. Three 125-hp. motors are used on each crane, one on each hoist and one on the bridge, with an auxiliary hoist using a 30 hp. motor for picking up light material. All of the cranes are equipped with Youngstown limit switches.

In addition to the inside cranes there is a 10-ton outside crane operating on a 320 ft. runway, and a second outside crane with a capacity of 15 tons on a 300 ft. runway. Thirty horsepower, 220-volt motors are used on both of these cranes.

A Bank of Safety Switches Located in the New Buildings—These Switches Are At the Terminals of the Cables Coming From the Substation

Machinery

When the new buildings were completed some of the machinery from the old shop was transferred to them and most of this equipment is group driven. For this group driven machinery, three 40-hp. motors conveniently arranged in groups are used. In addition to this group driven machinery, there are quite a number of individual machines with motors that range in capacity from 3 to 50 hp.

A 278 hp. synchronous motor, air compressor is utilized to keep up the power factor, and the shop heating system requires the use of 22, two and three horsepower motors for driving fans.

Considerable electric welding is done at the shop where two electric welding machines are in service most of the time. One of these is a Seamen-Wenzell machine with which three men can weld at the same time. The second

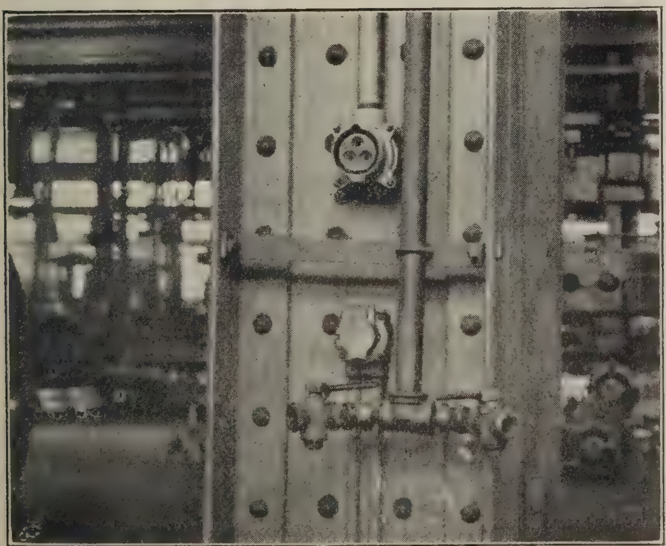

Part of One of the Outside Crane Runways, Showing New Buildings at the Left Which Were Constructed in 1925

is a Westinghouse portable type. The welding accomplished consists of general welding such as fire boxes, flues, bridges, building up cross-heads, flanges, etc. Power is derived in each case from a 220-volt motor-generator set.

In order to facilitate welding the new shop buildings have been equipped with 220-volt outlet receptacles which are conveniently located on the columns supporting the

Left—Switching Cabinet for Lighting Control
Right—Type of Fuse Cabinet in Use

buildings, so that the welding sets may be plugged in wherever they are needed. Another useful portable outfit is a small motor driven lathe which may be moved around as required and which finds its greatest usefulness in fitting bolts in engine frames. By locating this lathe close to the erection work, a great deal of time is saved in obtaining special bolts and small parts which may be



Arrangement of Outlets for Power and Compressed Air

turned and tried any number of times without going far from the job.

Headlight Maintenance

Headlight maintenance work is carried on at the Atlanta shops and all kinds of repairing of headlight equipment is done except armature winding. There are approximately 200 locomotives in the territory covered by the Atlanta shops and several different types of turbo-generators are used. Some of the other shops on the Southern are equipped for winding work, but at Atlanta all armatures that require winding are returned to the manufacturer. A good many of the reflectors used in the headlight cases are of the Golden Glow type.

When the locomotive goes to the shop for repair, headlight machines are removed and taken apart. All of the dirt is boiled off of them in a lye pot. The fields, armatures and brush holders are taken off and in that way each part is so cleaned that when the generator goes back on the locomotive it is practically the same as new.

Turbines are tested with compressed air and it is found practical to make all except the final test in this way. The principal trial is made to see if the machine runs free in the bearings. The final test is made after the turbine has been placed on the locomotive where 200 lb. of steam pressure is available.

No car lighting work is done in the Atlanta shops, but all work of this character is sent to the Safety Car Heating & Lighting Company which maintains a repair plant in Atlanta where all car lighting work is done under contract.

Recently the shops have equipped 32 locomotives with GRS intermittent train control apparatus. These locomotives will be used on the train control division of the Southern which is between Atlanta and Spencer, N. C.

Inspection

Inspection of electrical equipment is carried along on the semi-monthly basis. Every two weeks all of the motor bearings are inspected and if occasion requires, extra inspections are sometimes made. Oil is supplied to the bearings at intervals of every two weeks although in case of any doubt concerning a particular motor, a second inspection may be made within a few days. By following up this system of inspection, practically all repairs to electrical machinery have been eliminated.

The lighting system in the new buildings is modern. The two erecting shops are lighted by 750-watt lamps and the machine shop by 500-watt lamps, using RLM dome type reflectors. In the erecting shops, the lighting units are located over the tops of the cranes approximately 60 ft. above the floor, whereas in the machine shop the height is about 35 ft. Benjamin angle type reflectors are also used to a considerable extent.

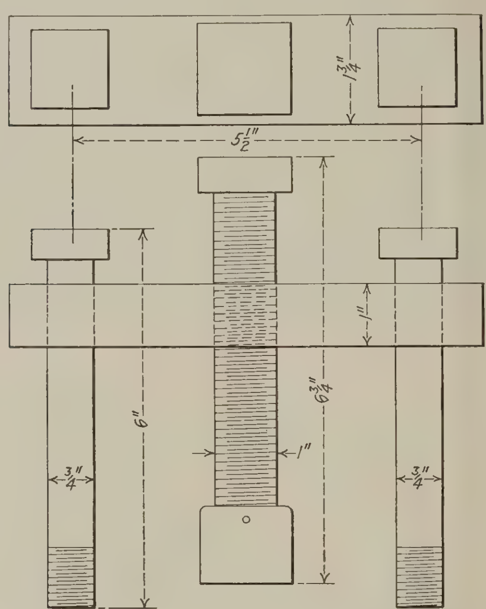
Each pit is equipped with three receptacles for inspection lights. All of this lighting is done with 110-volt current.

On the crane runways outside of the building, floodlighting is used. One 2000-watt floodlighting unit being used at each end of the runway.

The electrical force at the Atlanta shops consist of two electricians and two apprentice boys with six other men located at various places, but working out of the Atlanta shops. The time of this force is taken up principally with inspection and maintenance work so that the actual construction involved in the installation of the new electrical equipment when the new buildings were erected, was done under contract by the Walker Electrical Company of Atlanta.

Device for Removing Generator Heads

Every car lighting man knows how difficult it is to remove the heads at times from axle lighting generators.

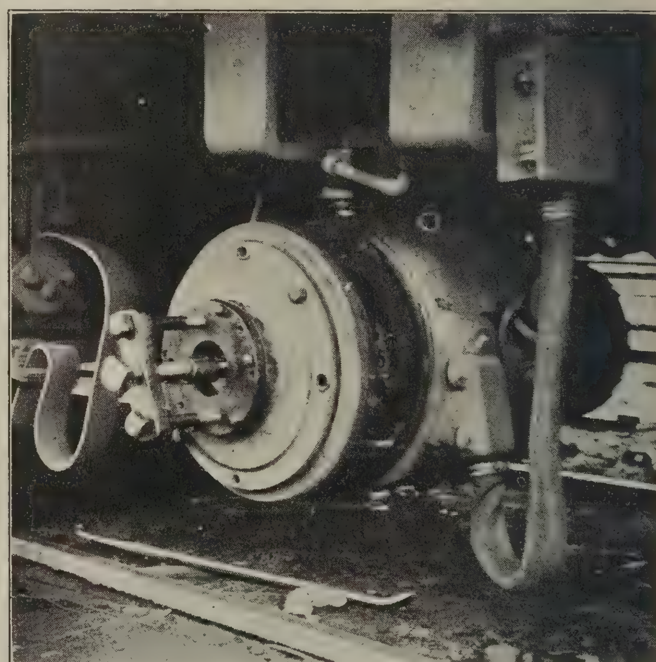


Sketch Giving Dimensions and General Design of Head Puller

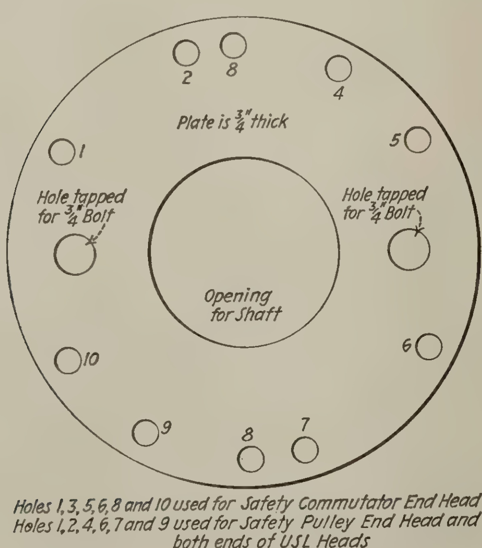
Sometimes they stick so tightly that it is almost impossible to get them off by any ordinary means. In order to overcome this particular maintenance obstacle an ingenious device has been developed by the Pullman electricians at the Union Station, Jacksonville, Fla.

The device is exceedingly simple in construction, easy to apply and most effective in performing its function. It consists of a standard pulley puller such as is used by the Pullman Company. As may be seen from the sketch there are required two six-inch bolts. Two ten-inch bolts are also needed. The ten-inch bolts are to be used on the pulley end, the six-inch bolts on the commutator end.

In addition to the bolts and yoke of the puller a very important adjunct is a large circular disk or plate. This



Showing How the Puller Is Applied to Generator



Holes 1, 3, 5, 6, 8 and 10 used for Safety Commutator End Head
Holes 1, 2, 4, 6, 7 and 9 used for Safety Pulley End Head and both ends of USL Heads

This Plate Is Bolted on to Head in Place of Grease Cap

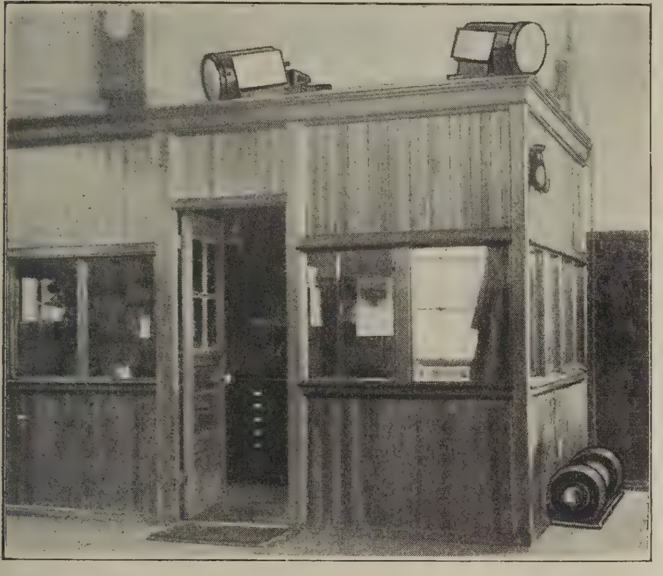
plate is drilled with a combination of holes to fit the grease cap of either the U. S. L. or Safety equipment on the commutator end or pulley end. It is also drilled and tapped for ¾-inch bolts.

After the grease cap and "lock up" has been removed, the plate is placed on the head the same as the grease cap and set up with the ⅜-inch cap screws used in holding the grease cap on.

Having fastened the plate to the head, the next step is to take the standard pulley puller and with the ¾-inch bolts secure it to the plate. Then turn the center bolt by means of a wrench and as the end of this bolt presses against the end of the shaft, the head will be pulled off easily and evenly.

Auxiliary Power House Lighting

At Richmond, Va., in the power house or compressor room of the Richmond, Fredericksburg & Potomac Railway, a scheme of auxiliary lighting has been devised by the electrical engineer of the road, as a protection against being without lights in the engine room, in the event of purchased power failing. On top of the office of the engineer which is partitioned off from the rest of the room are located two locomotive headlights. One of these point directly at the switchboard and the other at two reserve sets of steam driven a. c. generators which are ordinarily



With Headlights Above and Turbo-Generator on the Floor at the Right Illumination Is Quickly Supplied When Purchased Power Fails

idle but which are always ready to carry the load if necessary.

Prior to the installation of these lights when the power line failed at night the engine room was in darkness and it took considerable time to get the two machines running in parallel. Ordinarily the machines can be paralleled in about five minutes.

The two lighting units used are 10-in. Golden Glow headlight reflectors with 100 watt lamps. The power to light them is taken from a Pyle National turbine type K2, capacity 500 watts. As steam is always available it is an easy matter to get the lights working whenever the emergency arises.

A Little More About Nothin'

Absotively and posilutely, and I don't have in mind signifying perhaps. I want to convey the thought to all of my disciples as to how enthusiastically everybody fell for nothin'. In the railroad yard where I get my paycheck, my co-workers were so enthused and engrossed with the thoughts of being blessed with the opportunity to study my doctrines in the written page, once a month instead of verbally every day, they actually fell over me and one another getting to me.

During the encore, my straw hat was completely demolished, but "truth crushed to earth will rise again," and when I came up for air, the rim was down around my neck and the crown fit like a skull cap.

Congratulations were proudly received and apologies accepted for the outburst of esteem which nearly ended in a casualty for my helper, Squash, and which did end a perfectly good last-year's straw lid. The loss of the straw sky-piece didn't incur any great inconvenience though, because it snowed the next day and it wouldn't have looked just right for me to have been clad in a straw hat and ear muffs.

As for my helper, Squash; well, he's a negative quantity and if you know what a liability is, it will not be necessary for me to go into detail at this time. He is always going and never arrives. Some day he will meet himself coming back, then the forces being equal, all signs of motion will cease and we will be one step closer to perpetual motion. Every morning when he hibernates out of the dressing room, I relieve him of his cigarettes so he won't get caught smoking while out in the open spaces. He'd never get caught smoking on duty, but I would hate to have him caught transporting the things since it would look bad on my part for allowing him to carry them. I think it's an act characterized by economy and good management, don't you?

Well, brothers, now that we are acquainted, familiar, and known to one another, we're even; no friendship made nor animosity lost. I feel as though I can talk closer to you and tell you more about nothin'. The only new question I have raised thus far is relative to my helper, Squash. Squash and his wife have been married for ten years; he's baldheaded, except for a light fringe around his ears, has good understandings, well reinforced, waddles when he walks and nurses a popular four when he rides. And, believe me, he's a good rider; used to ride a horse. His horse is dead and his four has died. But he says at that he would rather ride a horse because you don't have to crank them nor pull them around the corner to the filling station. You just feed them oats and straight water and use the alcohol for other things. A horse, as you all know, don't use a radiator and besides there is more danger of the driver freezing up than the horse.

Squash is quite a student of nothin', and has been for ten years. Prior to that time he claimed he know all about everything, but now he knows all about nothin'. It's been a tedious undertaking.

I met his wife one day; cute little thing, jovial, weighs 165 pounds troyweight, and comes down to get his check on payday.

Squash is a good listener and I guess that is the reason he has been able to grasp so many of my ideas.—*Pinkey, the Wirecurler.*

A Wee Bit Smoke

Two old Scotsmen sat by a roadside puffing away at their pipes. Said Donald: "Mon, Sandy, there's nae sae muckle pleasure in smokin' at that, ye ken!"

"An' whit whey dae ye make that oot, Donald?" Sandy asked.

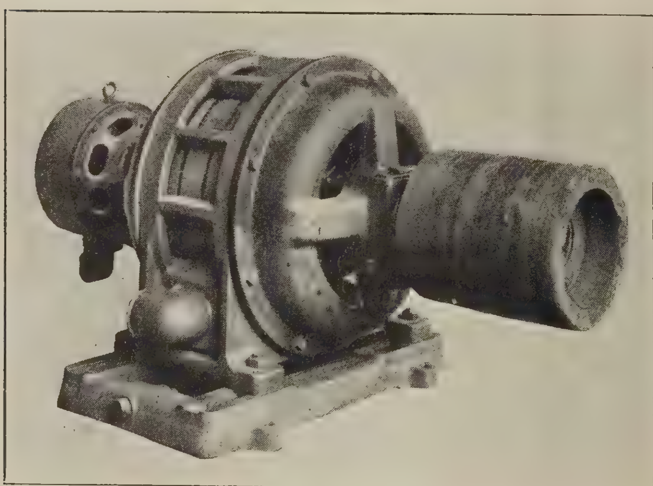
"A weel," Donald replied, "it's lak' this, when ye're a smokin' ye're ain bacey ye're grievin' sair at the expense of it, and if happy ye're smokin' some ither body's baccy ye'r wee bit pipe's rammit sae tight wi' it, ye canna draw it richt."

NEW DEVICES

General Purpose Synchronous Motors

A new line of synchronous motors for general purpose application has been developed by the General Electric Company. These motors are recommended to drive any load whose torque requirements have been heretofore met with a standard squirrel cage induction motor. The new motors are of the G. E. types TS and QS and are known as the 7,500 series.

These motors meet all the Electric Power Club requirements for a general purpose motor; give satisfactory



A 50 Horsepower, Six Pole, 1200 R. P. M., Form P K Synchronous Motor

starting characteristics; are of strong construction, and with minor changes, will operate at unity, 90 or 80 per cent power factor. The ratings range from 20 to 150 horsepower with speeds of 1,200, 900, 720 and 600 r.p.m. at 60 cycles. The motors are rated at 40 deg. continuous at unity power factor. At 90 per cent or 80 per cent power factor the temperature of the stator will not exceed 40 deg., with 50 deg. on the rotor.

Adequate starting torque is the most important feature in the design of the new motors, each motor being guaranteed to deliver the same starting torque with the same inrush current as the standard squirrel cage induction motor of similar rating. At full line voltage the motor will accelerate and synchronize a load whose torque is 100 per cent of the rated full load torque of the motor.

The motors are of the revolving field, salient pole type and are separately excited, usually by means of direct connected exciters. One of the principal advantages is in the amortisseur windings so designed as not to be a limiting feature in regard to heating. These starting windings will not become dangerously heated before the primary motor coils are overheated. Thus adequate overload protection in the a.c. lines will also protect the amortisseur windings from overheating resulting from failure to start, or because of operation without excitation.

With these motors, semi-automatic control is recommended, by means of which the field excitation is automatically applied. The motor is started by means of a manually operated, self-contained compensator. The operations required to start are therefore identical with the starting of a squirrel cage induction motor.

Gas-Engine Crane with Lifting Magnet

A recent development in the railroad field consists of a gasoline engine driven boom crane which is equipped with a lifting magnet. It is used for carrying rails or other track supplies and also for handling scrap. The

Fig. 1. Gas-Engine Driven Crane as Used for Handling Rails

crane is mounted on rails on top of a flat car and can be moved to any desired position on the car.

The crane can move to any point on its flat car and clamp there to unload rails or track supplies as shown, or to load scrap. The crane capacity is five tons and it

can swing through the full circle. It is mounted on a flat car and hence easily fits into a work or supply train. When clamped over one of the car trucks it can engage and propel itself, thus saving the time of engine and crew for yard work.

The crane, built by The Universal Crane Co., Cleveland, O., is usually driven by a 44 hp. gas engine or if preferred by a 25 hp. a.c. or d.c. motor. It can operate with a chain sling, a half-yard bucket, and the one illustrated is equipped with 4½ kw. generator driven by belt

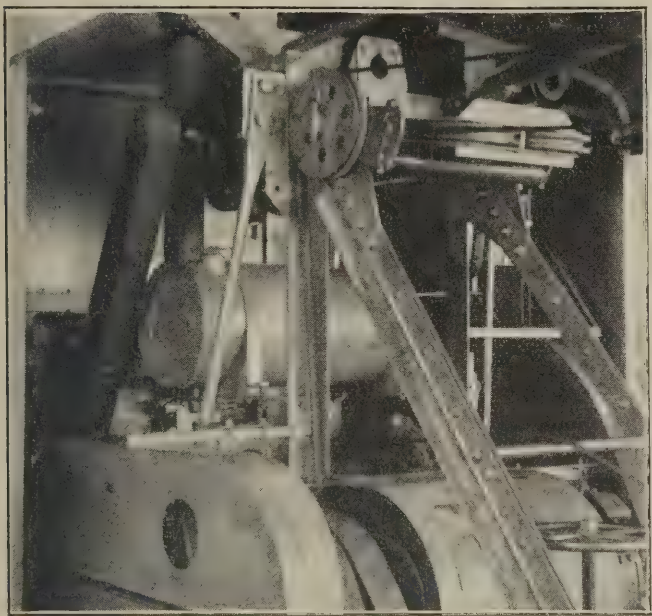


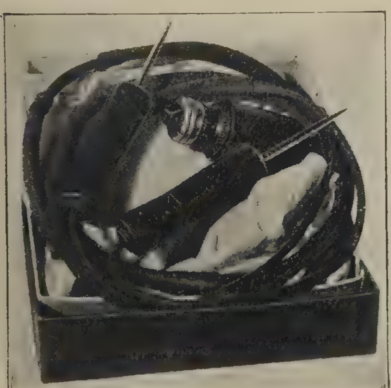
Fig. 2. The Generator, Belted to the Engine is Mounted on a Frame Above the Hoisting Machinery

from the main engine and operates a 36 in. diameter lifting magnet made by The Ohio Electric & Controller Co., Cleveland, Ohio. The location and drive for the magnet generator is illustrated by Figure 2.

Including one man, the cost of operation is about $15 per day and it can be used with magnet to load or unload scrap wheels, two wheels on axle, rails, spikes and with bucket to handle coal, earth or any kind of ballast.

Trouble Shooter

A device known as the Universal Trouble Shooter is now being manufactured by the Universal Test Equipment Company, Chicago, Ill. It consists essentially of a combination plug and socket, a length of cord and two specially made test handles. It is wired so that when the plug is screwed into a circuit and a lamp is placed in the socket, the lamp and test handles are in series in the circuit. With this arrangement, it provides a convenient method for testing short circuits, open circuits, grounds, etc.



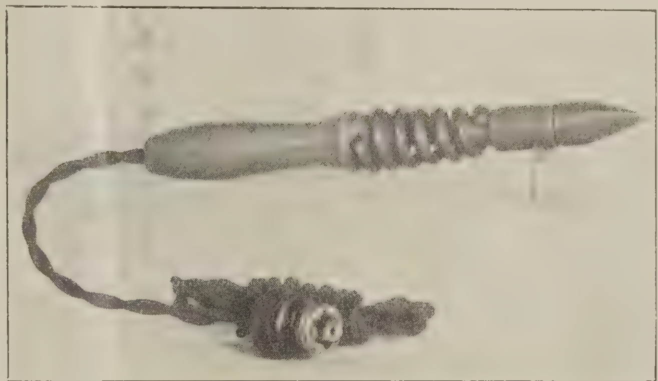
The Universal Trouble Shooter

The test handles are made of a Cutler-Hammer composition known as Thermoplax which is claimed not to warp or split. Each handle has a removable cap which permits the lead connections to be changed easily. The points are made of a specially hardened alloy which resists corrosion. For making cadmium tests on storage batteries, a separate cadmium point is provided which fits over one of the regular points.

Soldering Iron

A new soldering iron of light construction, designed to heat up quickly is now being marketed by the General Electric Company. This iron is made in standard sizes ranging from ½ in. to 1¼ in. tip.

Power consumption ranges from 70 watts for the smaller iron for light and intermittent use, to 350 watts for the larger size on heavy duty. The irons for heavy duty are provided with radiating stands for the purpose of maintaining the iron at the correct operating temperature when temporarily not in use. The rapid rate of initial heating is brought about by unusually good heat conduction between the heating element and the copper tip. Heat from the tip is prevented from reaching the handle



A 150-Watt, No. 3 Wooden Handle Type Soldering Iron with Stand; Length 12 In. Overall

by means of a special mechanical construction between the two, this being in the form of a spiral made from a steel rod. This also provides a rigid connection between the handle and tip.

Instead of mica, usually used for an electrical insulator in the heating unit of soldering irons of this type, the heating unit has an insulating powder so highly compressed that it becomes a good heat conductor and is capable of withstanding temperatures of more than 2,000 deg. F.

The iron is provided with a standard lead and connection plug. Its construction is simple, parts are few and all parts are replaceable.

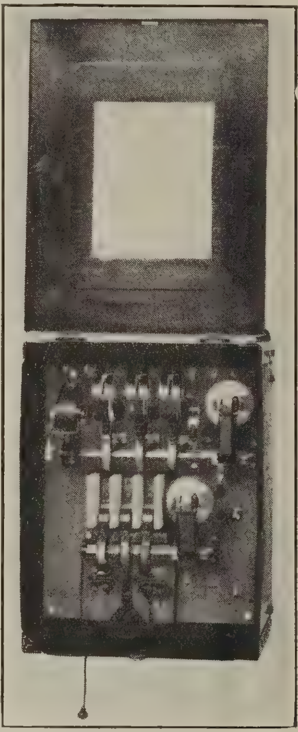
Induction Motor

The Ideal Electric & Manufacturing Co., Mansfield, Ohio, has brought out an induction motor, known as Type AA, which is said to be an improved type of the automatic, self-starting variety. The new motor, according to the manufacturer, will start on full line voltage and will not take as much current from the line as an ordinary squirrel-cage motor when started with a compensator on

the 80 per cent tap. Other characteristic features are low inrush, high starting torque, low first cost, low maintenance cost, remote control and freedom from expensive apparatus. The motor is mounted on a sliding base and is provided with a bracket that can be rotated 90 or 180 deg.

Redesigned Starters for Induction Motors

The General Electric primary resistance starters for squirrel cage induction motors, bearing the designation CR-7056-D-1, have been superseded by two new types, the CR-7056-D-3 in sizes up to 25 horsepower, and the CR-7056-D-4 in sizes from 25 to 50 horsepower. The 7056-D-3 has arc barriers and the 7056-D-4 starters are equipped with magnetic blowouts and arc chutes, enabling them to handle the larger motor currents.



A 75 Ampere, 550 Volt Automatic Starter for Squirrel Cage Motor

Both starters have an improved magnetic time interlock, an important change being that the operating spring now works by compression instead of tension. The interlock can thus be adjusted more easily.

Starting resistors are also redesigned and enlarged to give more capacity, and conform to Classification No. 16 of the Electric Power Club, which provides 200 per cent full load current or more on the first point for 15 seconds out of every four minutes.

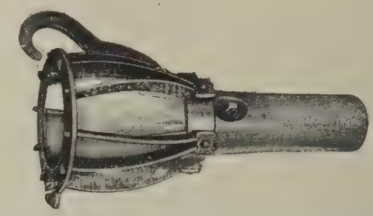
The enclosing case of the D-3 starters opens from the top, is ventilated, has two 1¼ in. knockouts in the top and has two knockouts of the same size in the bottom. These provide ample space for power and control wires. The cover may be padlocked shut if desired.

The D-4 enclosing case is larger than that of the D-3, in order to make room for the increased size of the resistor. This case opens on the side and, like that of the D-3, can be padlocked shut if desired. It is provided with two 2-inch knockouts in both top and bottom.

Both forms of starter are arranged for wall mounting and have an approximate weight of 122 pounds.

Non-Metallic Portable Extension Light

An improved type of portable extension light with a fibre lamp guard is now being made by the Benjamin Electric Manufacturing Company, Chicago, Ill. It has a strong fibre guard designed to prevent the lamp from rolling when placed on a flat surface. The fibre hook permits the lamp to be hung up, thereby releasing both of the workman's hands for the job. The fibre half shade is adjustable so that the lamp can be used from any position without blinding the workmen. The socket has a push through switch and flexible guards hold the lamp in position. Standard mill type, 25 or 50 watt lamps are



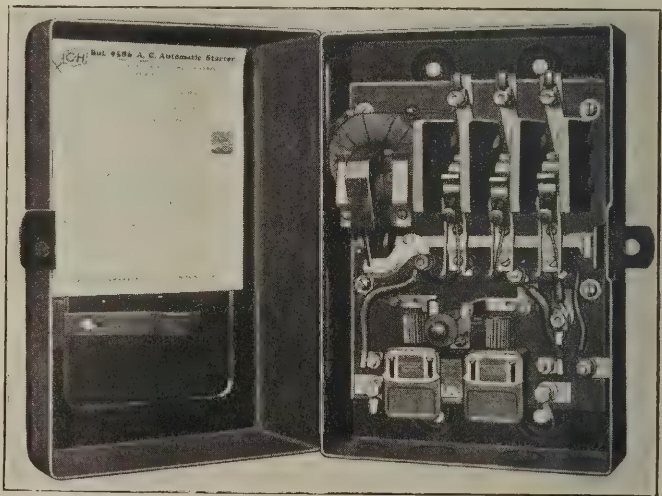
Improved Benjamin Fibre Hand Portable Lamp

used. The handle is made of maple. As the entire unit is non-conductive it can be hung on live bus-bars or laid on top of storage batteries without hazard.

Across-The-Line Starters

The Cutler-Hammer Mfg. Company, Milwaukee, Wis., has completed the design of an automatic starter for use in connection with alternating current motor drives, requiring motors of small and average capacities which can be connected directly across the line and where complete motor protection is desired.

These C-H "X" starters embody such features as small size, ruggedness of the switch mechanism, thermal overload relays, accessibility, and roominess in spite of the



Across-the-Line Starter With Thermal Overload Relay

small size, low-loss magnet construction, easy installation and a wide range of application.

The type "A" starter in the "X" series is a fully enclosed starter and employs a positive acting three-pole contactor, together with a thermal overload relay. This relay is extremely accurate, can be adjusted to individual motor loads, and is of fool-proof design. After it has been tripped by an overload it is reset by pressing the reset button without the need of making any replacement. The contact fingers employed are easily accessible for inspection without the use of tools, and can be as easily renewed. It is not necessary to take the starter from the case nor to dismantle it.

One starter takes care of all motor sizes, since only the heater coils need be changed to suit the ampere rating of the motor.

General News Section

The New York Central has ordered 10 multiple unit cars for suburban service from the Standard Steel Car Company.

The shops of the Pennsylvania at Pitcairn, Pa., were damaged by fire on April 2, to the estimated extent of $150,000. The tin shop and the air brake shop, with all their machinery, were destroyed, the burned-over area aggregating about 60,000 square feet.

The Great Northern has ordered a 100-ton oil-electric locomotive from the Ingersoll-Rand Company, the General Electric Company and the American Locomotive Company, which companies co-operated in its manufacture. This locomotive is for yard switching service in St. Paul.

The Central States General Electric Supply Company, Chicago, General Electric merchandise distributor, has taken over the business formerly carried on by the Central Electric Company of that city. The management and personnel of the Central Electric Company will continue to operate the business of the new corporation.

The National Carbon Company, Inc., a subsidiary of the Union Carbide & Carbon Corporation, New York has bought the battery business of the Manhattan Electrical Supply Company. The dry sells heretofore sold by the Manhattan Electrical Supply Company under the trade mark Red Seal will hereafter be manufactured and sold by the National Carbon Company, Inc., under the same trade mark.

The Pyle-National Company, who purchased the Oliver Electric & Manufacturing Company of St. Louis, Mo., in May, 1924, has erected a new addition to its plant at 1334 N. Kostner avenue, Chicago, into which the Oliver Company moved on March 1, 1926. J. A. Amos, vice-president and general manager of the Oliver Electric & Manufacturing Company, has been elected also vice-president of the Pyle-National Company.

The Northern Pacific now employs the radio as a means of advertising Yellowstone Park, the North Coast Limited and the Northern Pacific generally. Concerts are broadcast each Thursday at 7:30 p. m. from Gold Medal Station, WCCO, St. Paul, Minn. The program includes a travel talk which describes the progress of a tour from the Twin Cities to Yellowstone and return, including the scene aboard the North Coast Limited as it leaves Chicago.

The Sectional Electrical Committee of the National Fire Protection Association which is in charge of the National Electrical Code recently authorized the appointment of a representative from the Illuminating Engineering Society. Heretofore, the I. E. S. has not been represented on this committee and it has appointed as its representative John A. Hoeveler, manager, engineering department, Pittsburgh Reflector Company, formerly electrical and illuminating engineer of the Industrial Commission of Wisconsin.

The Cincinnati, New Orleans & Texas Pacific has asked the Interstate Commerce Commission for an extension of time to August 1 in which to complete the installations of automatic train control being made under the commission's two orders. The first installation is in operation and is completed except for some of the locomotives. On the second installation 170 of the 177 miles of road have been equipped and 40 of the 63 locomotives, while automatic signal changes have been completed on 132 miles.

The Northwestern Motor Company, Eau Claire, Wis., has appointed the following representatives: W. Newton Jeffress, Inc., Washington, D. C.; Shaffner & Allen, New York; Otis B. Duncan, Chicago; A. A. Culp, Birmingham, Ala.; William J. Roehl, St. Louis, Mo.; Rank & Goodell, St. Paul, Minn.; the W. H. Worden Company, San Francisco, Cal.; the Western Railway Supply Company, Portland, Ore., and the Koppel Industrial Car & Equipment Company, Koppel, Pa. W. Newton Jeffress of the Washington office has been appointed manager of sales for the Eastern region.

The Westinghouse Electric & Manufacturing Company has made a complete reorganization of its sales department, involving the reallocating of the managing personnel and the creating of several new activities. The change, which involves all departmental sales managers of the company, consists of the following appointments: Assistant to vice-president, E. H. Sniffin, formerly manager, power department; director of sales, T. J. Pace, formerly manager, supply department; certral station manager, G. H. Froebel, formerly manager, marine department; industrial sales manager, J. M. Curtin, formerly manager, industrial department; transportation sales manager, M. B. Lambert, formerly manager, railway department; assistant director of sales, A. C. Streamer, formerly assistant to manager, supply department; generating apparatus manager, H. W. Smith, formerly general engineer; traction apparatus manager, A. J. Manson, formerly manager, heavy traction division, railway department; motor apparatus manager, O. F. Stroman, formerly assistant to manager, industrial department; switch-gear apparatus manager, R. A. Neal, formerly head of switch section, supply department; distribution apparatus manager, G. A. Swain, formerly assistant to manager, supply department.

Electrical Engineers Semi-Annual Meeting

The semi-annual meeting of the Association of Railway Electrical Engineers will be held in Atlantic City on June 14 at the Hotel Dennis.

Old Timers' Club

For the purpose of social intercourse and discussion, a club has recently been formed composed of those who had been connected with steam railroad electrical work, either as railroad employees or engaged in railway manufacture or supply business or a continuous period of 20 years at the time of application. The proposed name for the club is the Railroad Electrical Pioneers Club. A. J. Farrelly of the Chicago & North Western has been appointed chairman, and J. Schribner of the General Electric Company, secretary-treasurer.

Suburban Electrification of Central Argentine to Be Extended

The electrified suburban lines of the Central Argentine around Buenos Aires are to be extended from Retiro Station (Buenos Aires) to Villa Ballester (12½ miles) and from Belgrano Station to Tigre (8 miles), according to Trade Commissioner Brady at Buenos Aires. The work is estimated to cost approximately £1,000,000.

National Carbon Company Builds New Plant

In order to take care of increasing business in the south, the National Carbon Company, Inc., has recently built a new brush finishing plant at Birmingham, Ala. The new plant, which is the seventh of its kind now operated by the company, will be devoted to the manufacture and distribution of all types of industrial brushes through southern territory.

The plant is located in a specially constructed building at 9th and 19th Streets. It has a floor space of 3,000 square feet and a potential capacity of 60,000 brushes per month. J. A. Hammond will have charge of the sales division of the new plant and J. B. Collins will be in charge of the carbon sales division. J. W. Suter is factory superintendent.

Submarine Cables to Span Puget Sound

The Okanite Company, Passaic, N. J., has received an order from the Puget Sound Power & Light Company for 46,800 feet of three-conductor 250,000 c.m. insulated submarine cable which will be used to span Puget Sound between Richmond Beach on the mainland side, and President's Point, on the Olympic peninsula, and thus connect the properties which the company recently acquired on the peninsula with the mainland system of interconnected power plants.

Two connections will be made between the points mentioned and each cable will be 23,400 feet in length and capable of furnishing 10,000 hp. The total weight of the two cables will be approximately 700,000 pounds.

New Lighting Equipment for Boston & Maine Trains

The extension of electric lighting to practically all trains of the Boston & Maine which enter and leave the North Station, Boston, is contemplated in plans announced by the railroad.

Material is now under order for the new electric light installation on the first lot of cars and locomotives. In all, some 600 open plaform cars and 200 locomotives are involved in the program, which is to be carried out at the rate of 40 cars and 10 locomotives a month. To get the maximum results from the improved train lighting, car ceilings will be painted in ivory.

The head-end system will be used, the current for the new lighting system being obtained from a turbo-generator mounted on the locomotive. This system was described on page 67 of the *Railway Electrical Engineer* for March.

American Brown Boveri Electric Corporation

The annual report of the American Brown Boveri Electric Corporation for the calendar year ended December 31, 1925, shows net income after depreciation and interest charges but before provision for income taxes of $1,708,-690, this representing the combined income of the parent company and its subsidiaries, the Condit Electrical Manufacturing Company, the Scintilla Magneto Company, Inc., the Moloney Electric Company, the Railway & Industrial Equipment Company, and the Electrical Development & Machine Company. The annual report is an interesting document in that it contains a seven-page illustrated statement to the stockholders signed by Laurence R. Wilder, president, amplifying the figures in the annual report, detailing the company's history and describing the plants of the parent company and its several subsidiaries. The illustrations include views of the several plants and typical installations of equipment. The combined income account follows:

Net profit from operations	$1,254,290
Other income	485,721
Gross income	$1,740,011
Income charges	31,321
Adjusted net income after depreciation and interest charges and before provision for income taxes	$1,708,690

Personals

Frank L. Eldridge, formerly general sales representative of the French Battery Company, Madison, Wis., has been appointed manager of the railway and telephone sales department of this company, following a consolidation of the telephone and railways sales departments. His headquarters will be in Chicago with offices in the Conway building, 111 W. Washington street. Mr. Eldridge has been identified with the telephone industry since 1903, when he entered the service of the American Telephone & Telegraph Company, serving in the operating and commercial department at Chicago. He left in 1912 to accept a position as assistant to the president of the Chicago Tunnel Company, the first automatic telephone company in Chicago, and two years later joined the National Independent Telephone Associa-

F. L. Eldridge

tion in connection with this association's service bureau. From 1915 until 1919 he was engaged in special sales work for the Kellogg Switchboard & Supply Company, Chicago. In the latter year he accepted a position with the French Battery Company to handle the sale of its products among telephone consumers, which position he held until his appointment as manager of the railway and telephone sales department, effective March 15, 1926.

G. Charter Harrison, general sales manager of the French Battery Company, Madison, Wis., has been elected a vice-president and director. He was born in London England, on September 21, 1881, and was educated at the University College School, London, and at the Institute of Chartered Accountants. He entered business as a clerk with W. B. Keen & Co., chartered accountants, London, and in 1906 was appointed manager of the System division of Price, Waterhouse Co., New York. For two years he was controller of the Russell, Burdsall & Ward Bolt & Nut Company. In 1916 he organized Management Engineering Practice, G. Charter Harrison, Associates, and later Stevenson, Harrison & Jordan, industrial engineers, New York. He originated scientific methods of cost predetermination, which represent the application of scientific management principles in cost accounting, and also developed scientific co-ordinated cost, planning and production methods. Mr. Harrison is retaining his interest in the firm of Stevenson, Harrison & Jordan.

G. C. Harrison

E. C. Wilson, sales director for the National Safety Appliance Company, with headquarters at Chicago, has been promoted to eastern manager to succeed K. E. Kellenberger, who has resigned to engage in other business. Mr. Wilson was born at Dunmore, Pa., on October 12, 1890, and graduated from the Lehigh University in the electrical engineering course in 1913. He completed the electrical apprentice course in the shops of the Buffalo, Rochester & Pittsburgh at Du Bois, Pa., and was employed for some time in the electrical department of the Northern Pacific at St. Paul, Minn. After leaving the Northern Pacific, Mr. Wilson entered the employ of the Central Electric Company in the railway sales department and a year and a half later resigned to become manager of the Chicago territory of the U. S. Light Corporation and also special representative of the Vapor Car Heating Company. After four years he was appointed western sales manager of the Ohio Locomotive Crane Company and on May 1, 1924, was appointed sales director of the National Safety Appliance Company, with headquarters at Chicago, which position he has held until his recent promotion.

E. C. Wilson

Arthur E. Allen, general manager of the Westinghouse Lamp Company, was elected vice-president and member of the board of directors at a meeting of the board held on April 7. Mr. Allen was chosen to fill the vacancy resulting from the death of Thomas G. Whaling, which was announced last month. Although Mr. Allen has been with the Westinghouse Lamp Company but a short time, he has a long record of progress with the Westinghouse Electric & Manufacturing Company. He is a native of Toronto, Canada. He entered the employ of the Westinghouse Electric & Manufacturing Company at the Newark works in 1902, subsequently being placed in charge of the test department. Later he became manager of the supply department of the New York sales office, then executive assistant to the manager, then manager of the New York district sales office and later general manager of the Westinghouse Lamp Company.

Arthur E. Allen

Charles H. Clark has recently been appointed raw material salesman for the Bridgeport Brass Company with headquarters at Boston, Mass. Mr. Clark's territory will cover the state of Massachusetts and the cities of Providence, R. I., and Meriden, Conn. Mr. Clark began his business career in 1903, as office boy for the H. Wales Lines Company, where he worked for 18 months. From that time on his positions were varied, being purchasing agent for one large firm, then salesman for another and finally he entered concert, oratorio and opera work which had always appealed to him. This line of work, however, became unprofitable just previous to the war and Mr. Clark went back into business life as a salesman in the New England states. Mr. Clark comes to the Bridgeport Brass Company after being connected with John

Charles H. Clark

Tredennick, Inc., of Boston, wholesale coal dealers, and is well acquainted with the section and conditions in the territory to which he is assigned.

K. E. Kellenberger, eastern manager of the National Safety Appliance Company, with headquarters at Chicago, has resigned to handle publicity work for the **Union Switch & Signal Company,** with headquarters at Swissvale, Pa. This work will also include the making of preliminary studies and surveys from the operating and traffic standpoint as to the utilization of signal devices for effecting economies. Mr. Kellenberger was born in Yates County, Kan., on December 5, 1883. He attended Ottawa University for two years, after which he entered Purdue University, from which he graduated in electrical engineering in 1907. After his graduation he became a special signal apprentice on the Pennsylvania Lines west of Pittsburgh, with headquarters at Logansport, Ind. In October, 1909, he was transferred to Canton, Ohio, where he remained until October 10, 1910, when he became signal inspector on the Chicago terminal of the Chicago and North Western, where he was connected with the construction of the important interlocking work of this station. He was promoted to division signal foreman on the Wisconsin division in December, 1910, and in June, 1911, was advanced to signal inspector in charge of construction for the entire Chicago & North Western system. On March 1, 1913, he was made signal supervisor for the West Iowa, Sioux City & Northern Iowa divisions and the lines west of the Missouri river, with headquarters at Boone, Iowa, and served in this capacity until August 26, 1914, when he received an appointment as senior railway signal engineer in the Bureau of Valuation, Interstate Commerce Commission, with headquarters at Chicago. In December, 1917, he left this position to become editor of Railway Signaling and signal and telegraph editor of the Railway Age. On June 15, 1924, he left this position to become eastern manager of the National Safety Appliance Company, which position he has held until his recent appointment.

K. E. Kellenberger

Samuel G. Hibben has been placed in charge of the combined engineering and illumination departments of the Westinghouse Lamp Company. Under his supervision will be grouped the commercial engineering department and the illumination bureau, the consolidated activities to be known as a new commercial engineering department. This reorganization has been announced as necessary in affording a broader and more direct service in regard to Mazda lamp applications, and, while Mr. Hibben retains the title of illuminating engineer, he nevertheless will now have under his direction many allied matters such as lamp performance and special lighting developments. Mr. Hibben's office has been moved from 150 Broadway, New York, to the Westinghouse Lamp Company, Bloomfield, N. J. Exhibition rooms and testing laboratories at that plant will be enlarged and considerable new lighting work undertaken.

L. J. Galbreath, until recently engaged in advertising and sales promotion activities for the Bridgeport Brass Company, has joined the American Brown Boveri Electric Corporation to take charge of publicity and sales promotion for that company as assistant to Earl G. Hines, recently appointed general sales manager.

Since graduation from Cornell University in 1917, Mr. Galbreath has served in executive and publicity capacities with the Niles-Bement-Pond Company, the Columbia Machine Works, and Malleable Iron Company, Brooklyn, New York, with the exception of time served afloat during the late war as an engineer officer in the U. S. Naval Reserve Force.

Norman Lee whose experience in transformer design is international has recently joined The American Brown Boveri Electric Corporation at Camden, New Jersey. After graduating as an electrical engineer from the University of Wisconsin Mr. Lee held several positions with the Thomson-Houston Co. of Paris, France. After ten years with that company he joined the A.E.F. in France. Following the war Mr. Lee designed and manufactured transformers under his own name.

In 1923 he returned to United States and joined the Allis-Chalmers Company as a designer of power transformers. Mr. Lee has been a frequent contributor to trade papers on technical subjects.

W. H. Vinnedge who until recently held a position as sales engineer with the Servell Corporation, has joined the railway engineering staff of the American Brown Boveri Electric Corporation. After graduating from Purdue University, Mr. Vinnedge joined the Westinghouse Electric & Manufacturing Company where he was engaged in the application of transformers, motors, meters, etc., to railroad work. He has also served as a sales engineer for the Duplex Light Company.

R. F. Fiske, for several years manager of the R. D. Nuttall Co.'s eastern office at Philadelphia, has been appointed sales manager in place of Q. W. Hershey. John E. Mullen, of the home office sales force, has been made assistant sales manager.

Obituary

Willard G. Carlton, superintendent of power, electric division and Grand Central Terminal, New York Central, died on Thursday, April 15, after a very brief illness. Mr. Carlton was born on February 20, 1869, in Warren, Ill., and was educated at the College of Mechanical Engineering, Cornell University, and was graduated from there in 1892. For some time after his graduation, Mr. Carlton was with the Chicago Edison Company, and went to the New York Central on October 1, 1905, about a year previous to initial electric operations, as superintendent of power for the Electric division. On January 1, 1915, he was appointed superintendent of power, Grand Central Terminal, in addition to his other duties, which positions he held until the time of his death. He was in charge of the operation of power stations, substations, transmission and distribution system, terminal service and boiler plants, and the supply of heat, light and power to the buildings in the Grand Central Terminal.

Railway Electrical Engineer

Volume 17 JUNE, 1926 No. 6

This issue of the *Railway Electrical Engineer* contains the progress reports of some of the committees of the Association of Railway Electrical Engineers. These will be presented at the semi-annual meeting of the association at Atlantic City on June 14. The committees which have furnished progress reports are those assigned to the subjects of train control, illumination, loose-leaf manual, and safe installation and maintenance of electrical equipment. The first three of these are brief and do not attempt to go into the detail which will be expected in the complete reports when they are presented at the annual meeting of the association in the fall.

Convention Reports

The committee on the safe installation and maintenance of electrical equipment has prepared a discussion which, although called a progress report, is most comprehensive in its findings and it is difficult to see how much more could be added to it. It will be remembered that a great deal of discussion took place at the annual convention of the association last year in Chicago relative to the grounding of electrical circuits. The information available at that time was apparently disconnected and uncertain. Although many opinions were expressed, it did not seem possible to arrive at any definite conclusions. The committee on safe installation and maintenance of electrical equipment has gone into the subject of grounding with great care and thoroughness with the result that the report contains much valuable information.

Resuscitation from electric shock has also been covered at considerable length. This is a subject upon which practically every one working around electrical equipment should be informed, and while the method described is probably not new to many, its place in the convention report is desirable since it will tend to put more emphasis upon a most important factor.

While the subject of train control has always been closely allied to the signal systems, it is beginning to be apparent that the various signal departments will have little or nothing to do with the train control equipment located on the locomotive, and that the pneumatic, mechanical and electrical apparatus on the motive power will be maintained and inspected in the roundhouse by special forces assigned to this work.

Train Control Maintenance

Many electrical engineers have already had train control problems thrust upon them and have had to work out some means of doing a creditable job. The subject is one which calls for no small amount of study and as everything points to the electrical engineer as the one who is going to be made responsible for the proper functioning of train control equipment—at least so far as the apparatus on the locomotive is concerned—the wise engineer will call all of his resourcefulness into play and devise ways and means of inspecting and maintaining the equipment in the most expeditious and satisfactory manner possible. Reliable short cuts must be developed so that a large number of locomotives can be inspected within a comparatively short time. Maintenance methods should be improved from time to time as knowledge is gained from the results on the equipment in actual service. It is an excellent opportunity for the electrical engineer to demonstrate his ability to cope with new problems and the measure of his value to his company will be largely reflected in the way in which he is able to meet his responsibilities in the train control developments.

At the recent convention of the National Electric Light Association a resolution was offered outlining the principles which should govern the sale of power to the railroads by the utility companies. In substance, the resolution states that power should be supplied to the railroad in any form desired at road-side distributing stations, or other suitable points of delivery, on the basis of a contract rate which will include only actual costs involved in the delivery and an agreed-upon rate of return upon the necessary investment, including profit.

Purchase of Electric Power

The resolution was offered by the railroad electrification committee and applies specifically to the sale of power for the electric operation of trains. In general, however, it indicates a change of attitude on the part of the power companies toward the railroad load. Power companies have in the past appeared rather indifferent to the railroad business, particularly if electric traction was involved. The principal reason for this has probably been that the load factor was poor; at one instant the load might be very great while a few minutes later it might be practically nothing. Furthermore, electrical equipment is more easily applied to manufacturing processes than it is to railroad maintenance and repair work.

The objection to the poor railroad load factor has now been largely overcome by the interconnection of power systems. E. J. Fowler, statistician of the Commonwealth Edison Company, at the N. E. L. A. convention stated that only 25 per cent of electric light and power users

now obtain current from isolated local plants. With power available in large quantities from several different sources, the railroad load becomes relatively small and the effect of poor load factor is minimized. It is probable that the power companies will adopt the resolution offered and if the industry also sees fit to develop the railroad market as it has already done with household appliances and manufacturing processes, then the time is near at hand when it will no longer be possible to say that electricity has not been applied as extensively in railroad service as it has in manufacture.

Rail Motor-Car Lighting

According to a statement made recently by an official of a western road, highway vehicles are not solving the rural transportation problem and the farmers and other residents living along branch lines of railroads are strongly favoring the retention of such lines rather than to see them abandoned for bus and truck transportation. The reason for this is not difficult to imagine. They do not really know which facility—railroad or highway—will give them the best service, but they do know that if the railroad is abandoned it will be next to impossible to rebuild it.

Eventually, of course, the facility which is able best to meet the transportation requirements will get the business and the excellence of that service will depend partly at least upon the electrical departments of the railroads. As an illustration, the lighting used may be considered. The traveling public has become accustomed to good car illumination and expects nothing else. Good lighting can be provided to better advantage for passenger train coaches and for rail motor cars than for highway vehicles. Good lighting equipment is available for rail cars, but it differs somewhat from standard car lighting equipment and before it is placed in service, possible operating conditions should be considered. If a motor car is to haul a trailer all or part of the time or at some future time, the effect on the lighting equipment must be considered if satisfactory results are to be assured.

Chromium Plated Reflectors

The hardness and corrosion resisting preperties of chromium have been known for a long time, but it is only recently that practical means for plating other metals with chromium have been developed. This has led to much recent speculation regarding the practicability of chromium plated reflectors for locomotive headlights, automobile headlights, floodlights, etc.

The particular advantages of a chromium plated reflector are that it is not corroded by sulphur fumes or water vapor and it can be cleaned as often as necessary without injuring its reflecting properties, since it cannot be scratched by ordinary grinding compounds such as emery. Furthermore, it is not injured by the temperatures to which headlight and floodlight reflectors are subjected. The principal disadvantage is that the coefficient of reflection is only about 65 per cent. The coefficient of reflection for silvered glass may be as high as 92 per cent, and for lacquered silver on a copper base it is usually about 75 per cent when the reflector is new. The glass reflector is costly when made in large sizes and the reflecting properties of the lacquered silver are subject to relatively rapid depreciation which cannot be corrected by simple methods of cleaning.

Fortunately for the mirrored glass type, a 14 in. parabolic reflector, which can be used in a small headlight case, with a 250-watt lamp provides adequate beam candle power for a locomotive headlight and is otherwise highly satisfactory. It would appear, therefore, that while there may be some possibility of using the chromium plated reflector for locomotive headlights, it will probably be better suited for use in automobile headlights, floodlights, etc.—uses which are not governed by such rigid specifications.

New Books

Safety Rules for the Installation and Maintenance of Electric Utilization Equipment.—Bureau of Standards, Washington, D. C., 72 pages, 5 in. by 7½ in., paper binding, non-illustrated. Price $0.15.

The booklet contains part three of the National Electric Safety Code along with the grounding rules contained in Section 9. The various sections of the book cover the following subjects: Rules covering methods of protective grounding of circuits and utilization equipment; scope of rules and general requirements; conductors, fuses, circuit breakers, switches and controllers; switchboards and panel boards; motors and motor driven machinery; electric furnaces, storage batteries, transformers and lightning arresters; lighting fixtures and signs; portable devices, cables, connectors; electrically operated industrial locomotives, cars, cranes, hoists and elevators; telephone and other communication apparatus on circuits exposed to supply lines or lighting.

The Engineering Index, 1925.—792 Pages, 7 in. by 9½ in. Bound in cloth. Published by the American Society of Mechanical Engineers, 29 West 39th Street, New York. Price $7, to members, $6.

The Engineering Index published each year by the American Society of Mechanical Engineers has for years been considered a necessary reference book by those who wish to keep in touch with current engineering literature. It is invaluable in any engineering library, and a great convenience, because of its completeness, to those who have occasion to consult it only occasionally.

The first volume of the Index appeared in 1892 and it has been published annually since 1906. Up to 1918 it was prepared and published by the Engineering Magazine Company, but since that time by the American Society of Mechanical Engineers. This volume, numbering nearly 800 pages, includes some 18,000 items which appear in engineering and other technical publications. More than 3,000 of these items are cross-references. Many 1924 publications received too late for inclusion in the 1924 Engineering Index, as well as periodicals appearing in 1925, which were received as late as February 1, 1926, are included in this volume. In the preparation of the index, the staff of the society reviewed more than 1,200 periodicals, reports and other publications regularly received during the year by the Engineering Societies Library, New York. The railway field, both steam and electric, is, if anything, even more completely covered than in former editions. This department includes rolling stock, terminals, shops, signaling, track and yards, together with all phases of construction, maintenance and operation.

Atlantic City Board Walk near Young's Million Dollar Pier

Semi-Annual Meeting of the A. R. E. E.

Progress Reports Will Be Presented on Monday, June 14, at the Hotel Dennis, Atlantic City

THE 1926, semi-annual convention of the Association of Railway Electrical Engineers will be held in Atlantic City at the Hotel Dennis on June 14. The progress reports are published in this issue of the Railway Electrical Engineer and presumably some others which have not been received will be presented to the members at that time. The meeting which will be held in the Ozone Room of the Hotel will begin promptly at 9:30 a.m. (D. S. T.).

In view of the constantly increasing importance of electrical work in connection with railroad operation, there is every reason to expect a large attendance at the convention. The program is as follows:

Address of the President.

Report of the Secretary-Treasurer.

Unfinished business.

New business.

Progress report of the committee on Safe Installation and Maintenance of Electrical Equipment.

Progress report of the committee on Loose-Leaf Manual.

Progress report of the committee on Illumination.

Progress report of the committee on Motors and Controls.

Progress report of the committee on Train Lighting.

For admission to the A.R.A. meetings or exhibits, go to the A.R.A. registration office at Young's Miilion Dollar Pier and present your railroad pass.

Progress Report of Committee on Safe Installation and Maintenance of Electrical Equipment

Committee:—

George T. Johnson, Chairman, assistant electrical engineer, New York, New Haven & Hartford; George Dodds, electrical engineer, Delaware & Hudson Shops; E. R. Hall, road foreman of electricians, Chesapeake & Ohio; Alex. Weir, electrical inspector, New York Central.

To the Members:

This report is intended to lay particular stress on the safety features involved in the installation and maintenance of electrical equipment and apparatus. The rules and practices recommended herein are not intended for the guidance of electrical workers alone, but they apply equally as well to machinists, millwrights, oilers and others who work around machinery operated by motors or other electrical apparatus.

INSTALLATION

General.

First.—All new work should be installed in the safest way possible.

Second.—Existing installations should in all cases be brought up to safety standards as soon as possible.

Third.—All work must be in accordance with the rules and regulations of the "National Electric Code," prepared by the National Board of Fire Underwriters, as issued, revised and in effect from time to time hereafter and such local ordinances as may be in effect where the installation is being made.

Fourth.—All conductors, however well insulated, should be treated as bare, to the end that under no conditions, existing or likely to exist, can a ground or short circuit occur, and so that all

leakage from conductor to conductor, or between conductor and ground, may be reduced to a minimum.

Fifth.—In all cases where a ground connection is required, it is recommended that these connections be made to a cold water pipe, which is known to form a permanent and positive ground. If a cold water pipe is not available, it is recommended that a ground connection be made by driving not less than a ½-in. iron rod or larger in the ground a sufficient depth to insure a permanent ground and that such grounds be inspected at frequent intervals, and if found defective, renewed. In all cases, approved ground clamps are recommended.

Sixth.—It is recommended that all new inside installations shall be made in approved conduit or approved armored cable, and when extensive repairs are made to old installations of open wiring, conduit shall be substituted.

Seventh.—It is recommended that all high voltage wiring (601-5,000) shall be in approved lead cable or armored cable, run in conduit where used for interior work.

Eighth.—The term commonly referred to as "CONDUIT" in this report, is intended to include all kinds of approved conduit.

Ninth.—Where any installation is not covered by the above, use good judgment to make it safe.

Tenth.—All buildings and compartments for housing electrical equipment should be fire-proof in construction, dry, well ventilated, free from hazardous conditions, with maximum of natural lighting supplemented with artificial and necessary emergency lighting.

Eleventh.—Easily accessible lockers of compartments should be provided for the storage of materials and tools. Floors must have even surface and afford secure footing. Railing and toe boards (or equivalent) must be provided for any platforms having an elevation 4 ft. or more above the floor and around all openings over 18 in. deep.

Twelfth.—Head room not less than 6 ft. 5 in. is recommended for all passage ways and stairways. Hand rails must be provided for all stairways and the treads of open type stairways should be provided with toe boards over exposed, live, or moving parts, working spaces or passage ways.

Thirteenth.—Sufficient exits, properly marked, must be provided to afford a means of exit under any possible condition arising from fire or failure of equipment.

Fourteenth.—Buildings or apartments for housing oil-filled apparatus should be isolated as far as possible by suitable fire-proof walls, partitions or other barriers with oil sills or other devices for retaining escaping oil. Walls of buildings adjoining out-door installations of oil-filled apparatus in addition to being of fire-proof construction should have doors and windows arranged to prevent spread of fires due to burning oil.

Equipment and Material.

First.—Use only such equipment and material which is inspected and approved by the Underwriters' Laboratories and which as far as practicable incorporate safety devices which will protect both operator and equipment.

Second.—In consequence of liability involved by accident, primary consideration should be given to the safety features rather than to the first cost.

Generators.

First.—All electric generators and supply equipment shall have the exposed non-current carrying metal parts permanently grounded. This to include frames of generators, switchboards, transformers, lightning arrestors, enclosed switches and operating levers. However, this rule does not necessarily apply to d.c. generators having one pole grounded.

Second.—Flywheels and belts should be guarded. Flywheel pits should be covered or guarded.

Third.—Rotating electrical equipment or prime movers of such design that through failure of any constituent part are apt to attain a dangerous speed must be provided with automatic stop or speed limiting device of such construction that they cannot be made inoperative.

Switchboards—Power panels or sub-stations. (Not distribution panels.)

First.—All systems should be of the dead front type.

Second.—All switches on circuits above 300 volts a. c. should be the oil type, preferably having separate cells for each pole and have proper disrupting capacities in order to insure the performing of its functions with safety and properly protect the apparatus to which they are connected.

Third.—Care should be taken in using only pure mineral oil having the following characteristics for use in oil switches:

Where not subjected to a temperature below zero degree C., 32 deg. F.

Flash point, 185 deg. C.
Burning point, 210 deg. C.
Freezing point, 10 deg. C.
Viscosity at 49 deg. C., 105 sec.

Where oil switches are installed in unattended places or unheated buildings, in outdoor installations or on pole lines, the oil should have the following characteristics:

Flash point, 155 deg. C.
Burning point, 180 deg. C.
Freezing point, 40 deg. C.
Viscosity at 40 deg. C., 80 sec.

The viscosity is to be determined by a Saybold Viscometer.

Fourth.—Differential relay protection should be installed between alternating current generators and switchboard busses.

Fifth.—All alternating circuit feeder circuits should be protected with automatic inverse time limit overload oil switches.

Sixth.—Switchboards should be so installed that there will be ample space between conductors and wall to permit workmen to make repairs with safety, this space to be enclosed behind locked doors.

Seventh.—All existing switchboards should have rubber mats in front and rear of same.

Eighth.—Fuses are not recommended where automatic circuit breakers can be used.

Ninth.—Reactance should be installed in feeders.

Tenth.—Remote (mechanical or electrical) controlled oil switches are recommended for all circuits having potential over 2,500 volts a. c.

Eleventh.—Means must be provided to make equipment and switches inoperative to unqualified and unauthorized persons.

Motors and Control Equipment.

First.—Strict conformance to the National Electric Code is recommended. Also local ordinances, where equipment is installed.

Second.—Each equipment should be provided with separate safety disconnecting knife switch to disconnect both control and motor from line so repairs may be made with safety.

Third.—All power lines supplying current to a motor must be dead on the load side of controller or starter when starting apparatus is in the "off" position.

Fourth.—All controllers with exposed live parts should be enclosed in safety cabinets, with doors so arranged that only authorized persons may have access to same.

Fifth.—Motor-starting rheostats should be enclosed in metal covers, with handles for external operation.

Sixth.—All protective devices used in connection with motor control apparatus should be provided with full magnetic or thermal overload and under-voltage protection with hand reset, except where used on automatic equipment it need not be hand reset.

Seventh.—Where motors are so installed that there is a liability of accident, adequate guards should be placed around same to protect workmen. This to include belts, gears or other transmitting devices.

Eighth.—Hand-operated starters and push-buttons of remote control starters should be within sight of the equipment controlled, unless such equipment is within an enclosure.

Ninth.—Where motors drive line shafts or particularly dangerous machinery, such as planers in wood mills, elevators, etc., it is recommended that emergency stop stations be provided in accessible places so the equipment may be stopped in case of an accident. It is further recommended that there shall only be one starting station.

Tenth.—The frames of all motors and each piece of control equipment must be thoroughly grounded.

Eleventh.—Caution placards admonishing danger should be conspicuously placed at such a location as to warn employees and others of the presence of high voltage and equipment.

Wiring.

First.—Strict conformance to the National Electric Code is recommended.

Second.—It is recommended that all new installations be made in conduit.

Third.—Special attention should be paid to the mechanical execution of the work, careful and neat rewiring, connecting, soldering, taping of conductors, securing and attaching of conductors and fittings are especially conducive to security and efficiency.

Fourth.—In laying out an installation, every reasonable effort should be made to secure distribution centers located in easy accessible places, at which points cut-outs and switches controlling the several branch circuits can be grouped for convenience and safety of operation. The places selected for cut-outs and switches should at all times be kept clean and accessible and the piling of boxes or storing material in front of same is prohibited. The load should be divided as evenly as possible and all unnecessary wiring avoided.

Fifth.—It is recommended that all high voltage wiring (601-5,000) shall be run in approved lead or armored cable, run in approved conduit, where used for interior work.

Sixth.—The installation of high potential circuits is adequately covered by the National Safety Code.

Seventh.—It is recommended that all single phase lighting circuits of over 30 amp. be run as a three-wire circuit, using an unfused, grounded neutral. Branch circuits may be run either as a two or three-wire system.

Eighth.—The use of fuses for the protection of motors is condemned.

Ninth.—(a) Entrance and branch line fuses must be provided as required by the National Electric Code, but where it is practicable to install automatic circuit breakers, they are preferred. The selection of circuit breakers to be governed by local conditions.

(b) In lighting circuits, the use of fuses is satisfactory when installed according to the National Electric Code.

(c) The capacity of the fuse should never exceed the capacity of the wire which they are to protect.

(d) One time or refill fuses. It is recognized that both types of fuses, when properly installed and maintained, perform the functions for which they were intended. It is further recognized that both types have characteristics both favorable and unfavorable and the type of fuse to be used depends largely upon local conditions, as well as the class of supervision and inspection maintained. This committee does not deem it advisable to recommend either type exclusively, as either type will protect operator when properly installed and maintained.

(e) All switches must be so designed that when installed the blades will drop open, and when of the fused type, the fuse must be on the hinged side of switch. In this design of switch the blades and fuses will be dead at all times when the switch is open.

Tenth.—No circuit shall be on more than one switch. It has been found in several cases where a line will have two or three switches feeding it, and an employee will pull one switch and still the line will be hot.

Portable Equipment.

First.—For portable equipment, other than small hand lights, it is recommended that armored cable or additional wire be used for grounding the machine. When armored cable is used, it must be so connected that it will form a grounded connection to the conduit system.

Second.—Safety type receptacles are recommended for connecting all portable power apparatus, such as welding machines, rivet heaters, etc., operating on a voltage of 220 or higher. By "safety" type receptacles is meant one which will embody the following features in combination with a switch or disconnecting device:

(a) The device cannot be connected to the receptacle unless the switch is open.

(b) The connecting plug cannot be withdrawn from the receptacle until the switch is opened.

(c) The switch cannot be closed unless the plug connection is connected with the receptacle.

(d) The plug should be provided with a grounded connection so that the ground conductor from the portable motor or device can be attached in a safe and effective manner.

Third.—The transformer type welding machines should be equipped with an automatic over-voltage release which will limit the voltage across the welding leads to not more than 60 volts, when the arc is broken or circuit is open. The iron core of transformer should be grounded similar to the frame of portable motors.

Fourth.—For portable extension hand lights, it is recommended that composition or other well-insulated sockets of the keyless type be used in connection with wooden handles or other insulating material to which is attached a well-constructed guard.

Maintenance.

First.—In the maintenance of electrical equipment, it is recommended that thorough systematic, periodic inspection be made and any improper or irregular condition found, correction shall be made immediately.

Second.—Equipment shall be kept thoroughly dry and clean.

Third.—When each inspection is made, it should include the supports sustaining the equipment which should be kept secure and rigid. All power transmitting devices such as belts, gears, etc., should be included in this inspection.

Fourth.—The inspector should see that all circuits are properly protected by automatic circuit opening devices properly set and operative.

Fifth.—It is suggested that there must be at least two employees present when repairs are being made to high tension apparatus or lines.

Sixth.—All motors operating turntables, elevators, transfer tables, line shafts or other machinery where a repairman is likely to be working concealed from view of the control station, a safety switch must be provided so that workman can lock it open before such work is started.

Seventh.—Before any work on cranes or their runways, the crane operator must be notified by the workman. A form might be provided for that purpose or simply a written note. The operator should sign the form which will be kept by the workman until repairs are made.

Eighth.—For the safety of repairmen and others the following suggestions are furnished:

Don't work on live circuits except when absolutely necessary, then take proper precautions.

Don't work on high tension apparatus until you are sure it is disconnected from the line and grounded.

Don't lay tools where they are liable to fall and cause damage or accident.

Don't feel a circuit to see whether it is alive or not. Use a meter or test lamp instead.

Don't wipe, oil or adjust a machine while in motion.

RESUSCITATION

It is recommended that instruction in the Schaefer or "Prone Pressure" Method of Artificial Respiration be given to employees monthly, or at least three times a year, and that periodic examinations be conducted to ascertain their knowledge of company rules and regulations in respect to safety precautions. Men engaged in test work of any description should be thoroughly familiar with the Schaefer or "Prone Pressure" Method of Artificial Respiration and all company rules and regulations pertaining to safety.

(The rules printed below for Resuscitation from Electrical Shock by the Prone Pressure Method are reprinted by courtesy of the National Electric Light Association, 29 West 39th street, New York, N. Y.)

TREATMENT FOR ELECTRICAL SHOCK

An accidental electrical shock usually does not kill at once, but may only stun the victim and for a while stop the breathing.

The shock is not likely to be immediately fatal, because:

(a) The conductors may make only a brief and imperfect contact with the body.

(b) The skin, unless it is damp with perspiration or wet, offers some resistance to the current.

The life of the victim depends upon the prompt and continued use of artificial respiration. The reasons for this are:

(a) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(b) If the body is not thus repeatedly supplied with air, suffocation occurs.

(c) Persons whose breathing has been stopped by electrical shock have been reported restored after artificial respiration has been continued for approximately four hours, and the treatment should be continuously applied until rigor mortis (stiffening of the body due to death) sets in.

The Schaefer, or "prone pressure" method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(a) It is immediately available.

(b) Easy performance; no apparatus and little muscular exertion required.

(c) Larger ventilation of the lungs than by the supine method.

(d) Simplicity, the operator makes no complex motions and readily learns the method.

(e) No trouble from the tongue falling back into the air passage. The first impulse is expiration and any foreign substance in the mouth or air passage will likely be expelled.

(f) No risk of injury to the liver or ribs if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

INSTRUCTIONS FOR RESUSCITATION

Follow these Instructions Even if Victim Appears Dead

I.—Free the Victim from the Circuit Immediately

1. Quickly release the victim from the current, being very careful to avoid receiving a shock. Use any dry non-conductor (rubber gloves, clothing, wood, rope, etc.) to move either the victim or the conductor. Beware of using metal or any moist material. If both of the victim's hands are grasping live conductors endeavor to free them one at a time. If necessary shut off current.

Begin at once to get the subject to breathe (resuscitation) for a moment of delay is serious. Use "Prone Pressure Method" for four (4) hours if necessary, or until a doctor has advised that rigor mortis has set in.

Observe the Following Precautions

(a) The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains

Fig. 1

in contact—the nails are dangerous. If this is impossible, use rubber gloves, a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the conductor, so as to break the electrical contact.

(b) If the bare skin of the victim must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only *one* hand.

If the man receives a shock while on a pole, first see that his belt is secure around the pole, if possible above cross-arm so victim will not fall, then break the current. Pass a hand-line under his arms, preferably through his body belt, securely knot it, and pass the end of the line over the first cross-arm above the victim. If you are alone, pass the line once around this cross-arm. If you are not alone, drop the line to those at the base of the pole. As soon as the rope is taut, free the victim's safety belt and spurs and descend the pole, guiding the victim. When the victim is about three feet from the ground, lower rapidly so that the victim's feet hit the ground hard.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an axe or a hatchet with a dry wooden handle, turning your face away to protect it from electrical flash.

II.—Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.) If the mouth is tight shut, pay no attention to the above-mentioned instructions until later, but immediately begin resuscitation. The patient will breathe through his nose and after resuscitation has been carried on a short time, the jaws will probably relax, and any foreign substance in the mouth can then be removed. Do not stop to loosen the patient's clothing; every *moment of delay is serious.*

2. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow with the face resting on hand or forearm so that the nose and mouth are free for breathing. (See Fig. 1.)

3. Kneel, straddling the patient's hips, with the knees just below the patient's hip bones or opening of pants pockets. Place the palms of the hands on the small of the back with fingers resting

Fig. 2

on the ribs, the little finger just touching the lowest rib, the thumb alongside of the fingers, the tips of the fingers just out of sight. (See Fig. 1.)

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject. (See Fig. 2.) This operation, which should take from two or three seconds, *must not be violent*—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs, the diaphragm is kept in natural motion, other organs are massaged and the circulation of the blood accelerated.

5. Now *immediately* swing backward so as to completely remove

Fig. 3

the pressure, thus returning to the position shown in Fig. 3. Through their elasticity, the chest walls expand, and the pressure being removed the diaphragm descends, and the lungs are thus supplied with fresh air.

6. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing, the proper rate may be determined by counting—swinging forward with each expiration and back with each inspiration.

7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight

clothing about the patients' neck, chest or waist. (KEEP THE PATIENT WARM.) Place ammonia near the nose, determining safe distance by first trying how near it may be held to your own. Then the assistant should hit the patient's shoe heels about twenty (20) times with a stick, and repeat this operation about every five minutes, until breathing commences. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. Continue artificial respiration without interruption (if necessary for four hours) until natural breathing is restored. Cases are on record of success after three and one-half hours of effort. The ordinary tests for death are not conclusive in cases of electric shock and doctors must be so advised by YOU, if necessary.

9. When the patient revives, he should be kept prone (lying down)—and not allowed to get up or be raised under any consideration unless on the advice of a doctor. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of hot ginger tea or coffee.

The patient should then have any other injuries attended to and be kept warm, being placed in the most comfortable position.

10. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition, and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, he should be kept in a prone position and placed upon a hard surface (door or shutter) or on the floor of a conveyance, resuscitation being carried on during the time that he is being moved.

11. A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently, the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if normal breathing stops, artificial respiration should be resumed at once.

III.—Send for a Doctor

If other persons are present when an accident occurs, send one of them for a doctor without a moment's delay. If alone with the patient, do not neglect the immediate and continued resuscitation of the patient for at least one hour before calling a doctor to assist in further resuscitation efforts.

A published, up-to-date list of doctors posted by the company is recommended.

IV.—First Care of Burns

When natural respiration has been restored, burns, if serious, should be immediately attended to while waiting for the doctor to arrive.

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface should be saturated with picric acid (0.5 per cent.). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water, or it may be protected with vaseline, carron oil, olive oil, castor oil or machine oil, if clean. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchief, or other soft cloth, held tightly in place by a bandage.

The same covering should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it. Do not open blisters.

The prone-pressure method of artificial respiration is equally applicable to resuscitation from electrical shock as well as all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes, or to other causes.

GROUNDING—GENERAL

Attention is called to the gradual increase in switch capacities, and it is recommended that where grounding wires are to be used in installations of over 600 amperes the sizes called for in the National Electrical Safety Code be discarded and the proper size of wire be worked out allowing a safety factor of 3.

Grounding has been neglected in the past, but it is recognized that it is as necessary to safety of property and life as other rules and regulations, and particular attention must be paid to the engineering and maintenance in order to secure the best results.

Ground connections have in recent years come to play an important part in electrical systems of almost every kind. One of their chief functions is that of protecting persons against electrical dangers. When depended upon for this purpose, they should be carefully made, because if they are poorly made, or inadequate for the purpose for which they are intended, loss of life or serious personal injury may result.

The purpose of a ground connection is to keep some point in an electrical circuit, or some conducting body, at, or as near as practical to, the potential of the ground in order either that safety to life and property may be secured, or that there may be increased convenience and continuity of service in the operation of electrical systems.

Although special emphasis must be given to life hazard, the same careful requirements for a ground connection must be met in order to reduce property hazard, increase convenience of operation and provide continuity of service.

The fire and accident hazard which exists where there is a high resistance or deteriorated ground connection is well known, and is shown by accident records. This hazard might be the result of fuses not blowing when the circuit becomes grounded; the arc may, therefore, hang on and cause fire. Protective devices might not function. Therefore, it is very advisable to maintain a low resistance and reliable ground circuit at all times.

The various types of ground connections in common use may be enumerated as follows: Driven Grounds, Plates, Strips, Patented Devices, and Water Pipes.

Substantial construction is one of the first considerations in making ground connections of any type and should never be sacrificed to expediency; for, if grounding is poorly done it might in most cases as well not have been done at all; ground wires break, clamps come loose, electrodes corrode away, and even though repairs are constantly attended to, the protection afforded may be inadequate and unreliable. Moreover, the presence of a ground connection of any kind engenders a feeling of security which is false unless the materials and workmanship are of the best. Too much emphasis can hardly be laid upon the necessity for carefulness in this particular feature of electrical practice.

Water piping systems afford by far the best grounding systems obtainable, and should be used for grounding purposes wherever possible. Due to their great extent, water systems have a very low resistance, usually only a fraction of an ohm. Furthermore, they are of a very permanent nature, and connections to them are generally easy to install and inspect.

Water systems have such a comparatively low ground resistance that where they are in proximity to pipe or plate grounds it has been found that a difference of potential will exist between the two during ground fault conditions, which may constitute a hazard to life unless they are connected together. An additional hazard may also exist when ground currents, resulting from a fault foreign to the station, return through a piping system which is isolated from the station ground. For safety considerations, therefore, water pipes when adjacent to equipment to be grounded should always form an integral part of the grounding system. Since there is no danger to water pipes of electrolysis by stray alternating currents, the permission to ground to water systems should not be difficult to obtain, especially in view of the great advantage to the public in the protection of human life and the slight disadvantage, if any, to the water utilities.

In making connections to water piping systems it is, of course, advisable to ascertain if the piping is large enough, and if the material used in the pipe joints has a low enough resistance and sufficient thermal capacity to carry the maximum possible ground fault currents. Care should also be exercised to electrically connect all parts of the piping systems liable to be physically disconnected and to shunt the pipe system where necessary around meters and shut-off cocks, in order to keep the connection with the underground piping system continuous.

Unfortunately, water systems are available only in built-up districts, and, as a rule, can only be taken advantage of at indoor and moderate voltage substations.

At high tension substations in outlying districts it is generally necessary to resort to artificial grounds such as pipe or plate grounds. From the results of the survey it is interesting to note that the tendency is away from the use of plate grounds and toward the greater use of pipe grounds, due principally to the fact that in most cases the same results can be obtained with driven pipes at a much less expense than with plates. See Appendix "A" for characteristics and proper methods of installing ground pipes.

Although a single pipe ground has a higher resistance than a single plate ground, a pipe ground resistance of almost any desired value can be obtained by multiple grounding; that is, by connecting numerous pipes in parallel. In this way a ground of

a given resistance can be obtained more economically with pipes than with the use of plates, and in addition the multiple pipe ground will have the advantage of providing a well-distributed ground which, as pointed out previously, is a very important requirement. For average conditions it can be stated that pipe grounds have the advantage over the various forms of buried grounds, in that they

(a) Are more economical

(b) Are more easily installed, since no excavation is required.

(c) Allow for convenient inspection and test, since connections can be made above ground.

(d) Provide a distributed ground over a considerable area when used in multiple.

(e) Are capable of reaching depths of 20 feet or more when necessary to reach permanent moisture level.

There are many patented ground devices on the market, but very few companies reported their use. In general, it appears that the same results can be obtained by the use of pipes and at less cost.

It may be advisable, in some cases, to use other forms of artificial grounds than pipe grounds. For example, where the ground area is very limited it may be impossible to drive a sufficient number of pipes to obtain the required minimum value of ground resistance, in which case ground plates may give better results. For other localities, where the bed rock is near the surface of the ground, it may be out of the question to drive pipes or to dig deep enough to set ground plates, in which case the best procedure is to bury long, narrow strips of metal in trenches dug as deep as the rock layers will allow.

In arid regions and in localities with sandy or rocky formations it is generally very difficult to obtain a good ground with any type of ground electrode. The effect of the type of soil on the value of the resistance of a ground connection is shown very clearly in Table I. In the far west, where grounding difficulties are frequently encountered, satisfactory grounds have been obtained by grounding to the steel casings of deep wells. These casings are generally 6 to 10 inches in diameter and may reach a depth of 50 to 150 feet.

TABLE I

MEASUREMENT OF GROUND RESISTANCE BY THE BUREAU OF STANDARDS

Summary taken from the Electrical Review, June 16, 1918

No. of grounds tested	Soil	Aver. Resis.	Minimum resis.	Maximum resis.
24	Fills and ground containing more or less refuse, such as ashes, cinders and brine waste	14	3.5	41
205	Clay, shale, adobe, gumbo loam and slightly sandy loam with no stones or gravel	24	2.0	98
237	Clay, adobe, gumbo and loam mixed with varying proportions of sand, gravel and stones	93	6.0	800
72	Gravel, sand or stone with little or no clay or loam	554	35.0	2,700

Much benefit can also be obtained by treating the soil surrounding electrodes with chemicals, such as ordinary salt, copper sulphate, etc., because, of the total resistance of a ground connection, the most important part is contributed by the soil, the resistance of the electrode and the contact resistance between electrode and soil under ordinary conditions being negligible.

The electrical conductance of any soil is by means of the electrolytes formed by moisture combining with the soluble acids, alkalies and salts in the soil, and where they are lacking their artificial introduction will show excellent results. It should be kept in mind, however, that artificially treated soils require close attention and inspection, as the chemical must be renewed from time to time. Very few companies report the use of chemicals and their use is recommended only in overcoming unusually adverse grounding conditions.

The resistance of a ground connection can also be reduced by burying the ground electrode in coke, or, in other words, replacing a volume of earth of high resistivity surrounding the electrode with an equal volume of coke of low resistivity. Since the coke constitutes virtually an extension of the electrode, it should have a large area of contact with the soil in proportion to its volume. It is interesting to note that tests conducted by the Bureau of Standards show that whether the coke is wet or dry makes but very little difference, as far as the resistivity of coke is concerned; that is, moisture changes in affecting the resistance of ground connections made with coke act only on that part of the resistance contributed by the soil. As compared with the use of chemicals, coke has the advantage that it does not have to be renewed, but has the disadvantage that it is necessary to excavate to get the coke in place. Furthermore, great care must be exercised to see that the coke is well packed, because, as discovered in tests made by one company, small arcs were drawn when heavy currents passed through the ground which set the coke on fire, melting some soldered joints and burning the connecting leads open.

The greatest disadvantage in the use of either coke or salt is the increased rate of corrosion of the electrode. Where such materials are used it is, therefore, necessary to examine the ground electrodes often and renew them when necessary. Of the chemicals, copper sulphate has the advantage over salt in that no corrosion seemingly attends its use, because when electrolysis takes place between the earth and the electrode there is a tendency for copper to be deposited on the electrode, which will preserve it. Comparative tests on copper plates buried in coke treated with salt and with copper sulphate showed that at the end of three months the copper wires leading to the plates buried in salted coke were completely eaten off and one-third of the area of the plate had wasted away. The plates buried in coke treated with copper sulphate were only slightly pitted, due to the activity of various salts in the soil.

The size of the ground bus required depends, of course, on the length of connections between ground electrodes and on the maximum ground current under short-circuit conditions, and in many cases will require a conductor size larger than No. 0 copper.

If grounding conditions near the various pieces of equipment to be grounded are not favorable, then it may become necessary to run the ground bus some distance to a better grounding point. Under all conditions, however, as good a ground as possible should be made near the equipment so as not to depend entirely on long connections to distant points.

The connection of the bus to the ground electrodes and between the equipment and the ground bus should be as short and direct as possible, very reliable, free from the likelihood of mechanical injury and made in such a manner as to be accessible and easily inspected. The location of the ground connections should also be such that the chance of their being struck by an arc to ground and burned off is reduced to a minimum.

Each piece of equipment should be connected to the ground bus by a direct individual connection, which should be large enough to carry the maximum short circuit currents which may be imposed on the ground connection. In case it becomes necessary to group ground connections on a common lead, then the grouping should be such that high tension safety grounds, low tension safety grounds, power grounds and lightning arrester grounds are segregated and connected to the main ground bus over different routes.

The survey on grounding practice shows that the majority of companies terminate the overhead ground wire on overhead lines one or more spans away from the substation, the object seemingly being to prevent lightning disturbances from entering the substation. In several cases, however, it was stated that the object of isolating the overhead ground wires from the substation grounds was to reduce the complication of numerous wires entering the substation. On a well-grounded overhead ground wire, lightning disturbances are probably dissipated before reaching the station. At any rate, the disturbances entering the station over the ground wire should be no greater than those entering over the power lines which discharge into the lightning arrester grounds, which in turn are generally connected to the station ground. This indicates an inconsistency in practice, and if no ill-effects are experienced from the connection of lightning arrester grounds to main station ground, none should be expected from connecting the overhead ground wires to the same grounds. That this reasoning is substantiated by actual operating experience is borne out by the fact that a number of the largest companies operating extensive overhead transmission systems connect the overhead ground wires to the substation ground and have experienced no ill-effects whatever from the connection. As a matter of fact, many advantages are claimed for operation with overhead ground wires connected to substation grounds since it improves the transmission line as well as the substation grounds, resulting in improved relay action because a positive ground return is provided for short circuit currents, and reduces the hazard to life due to potential gradients in the earth between the transmission line and substation grounds. In this connection it is interesting to note that two large companies are compelled to connect the overhead ground wires to their substation grounds in order to eliminate hazardous potential gradients under abnormal conditions. In each case improvement in relay operations were also reported after the connections were made.

It is evident, therefore, that in order to obtain the full benefit

of overhead ground wires they should be connected to the substation grounds. This connection is usually made through the substation steel switching structure, which in turn is connected to the main station ground at numerous points, but in many cases it may be desirable to make a direct copper connection to the station ground.

Eight companies reported that operators had been shocked when in contact with the operating mechanism of disconnecting switches. The mechanisms in all cases were supposedly well grounded, but no additional safety features, such as insulated platforms or rubber gloves, were used. The shock in these cases were evidently

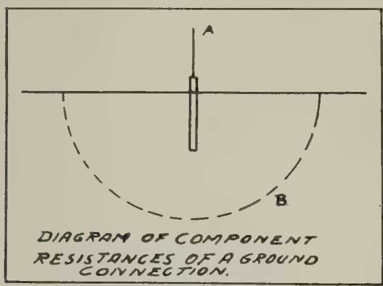


Fig. 1

due to potential gradients between the ground connection and ground. As previously pointed out, the greatest portion of the resistance of a ground connection is in the soil within a few feet of the ground electrodes; consequently, a person standing or walking near a ground electrode, or, worse yet, standing on the ground and touching a grounded switching structure or operating mechanism would be subjected to dangerous potentials in case of heavy current flow through the ground connection.

This indicates that operating mechanisms of disconnecting switches must not only be well grounded, but also grounded in such a way as to eliminate hazardous potential gradients. This requires a well distributed low resistance ground near the operating mechanism and under the path or walk leading up to the switch, so that the operator can leave the switch in safety in case of trouble.

Furthermore, sole reliance should not be placed on ground connections, because there is a possibility of their breaking or burning off at a critical moment. Consideration should, therefore, be given to the use of insulated platforms, removable impregnated wooden operating handles which can be kept in a dry place, or rubber gloves, by operators when operating disconnecting switches.

To obtain continuous and reliable service from grounding systems requires a systematic routine inspection and the measurement of the electrical resistance of ground electrodes and all connections comprising the system. The importance of adequate ground connections is so great that the practice of making periodic tests is highly commended.

Of those making periodic measurements, the usual practice is to make them at intervals of one year. This can be considered as a satisfactory interval as serious deterioration by corrosion, except where chemicals or coke are used, cannot be expected in a single year. The possibility of mechanical injury, however, exists at all times, and visual inspections should be made at shorter intervals in order that any defects which may exist can be remedied at the earliest practicable moment.

The characteristics of a ground connection which should be known are resistance, capacity to dissipate energy, and possible potential gradient in the vicinity of a ground electrode when heavy currents flow to ground. In general, it can be stated that if a well distributed multiple ground system meets resistance requirements, it is not likely to fall short in regard to the other two. As the test for the second requirement takes considerable time and consumes a large amount of energy, it can be dispensed with except for certain cases where doubt exists as to the ability of a ground connection to dissipate large amounts of energy.

Although the characteristics of the potential gradient in the vicinity of a ground electrode are already well known, a test should prove of great assistance in laying out a grounding system

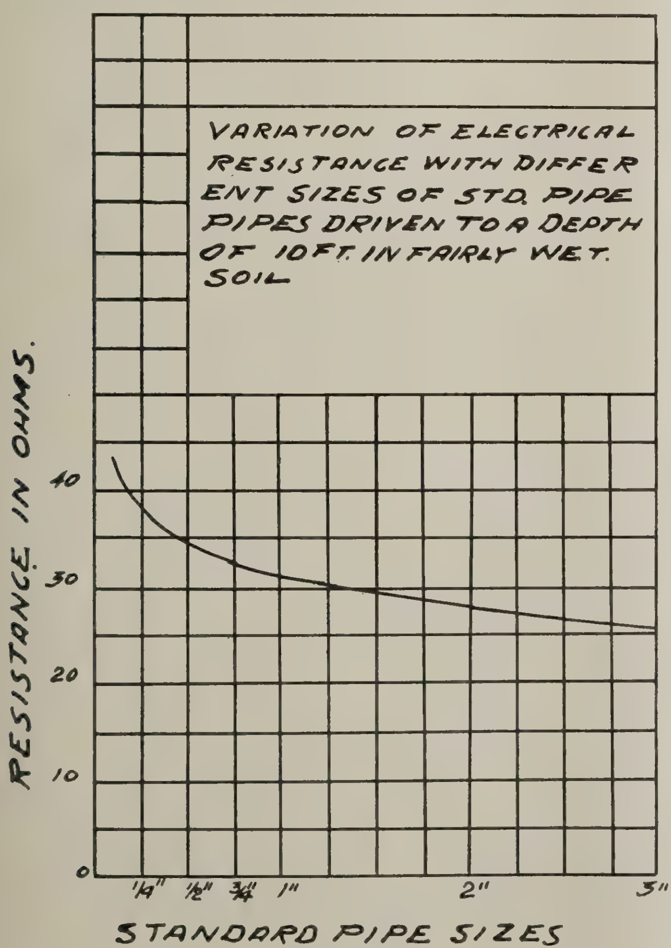


Fig. 2

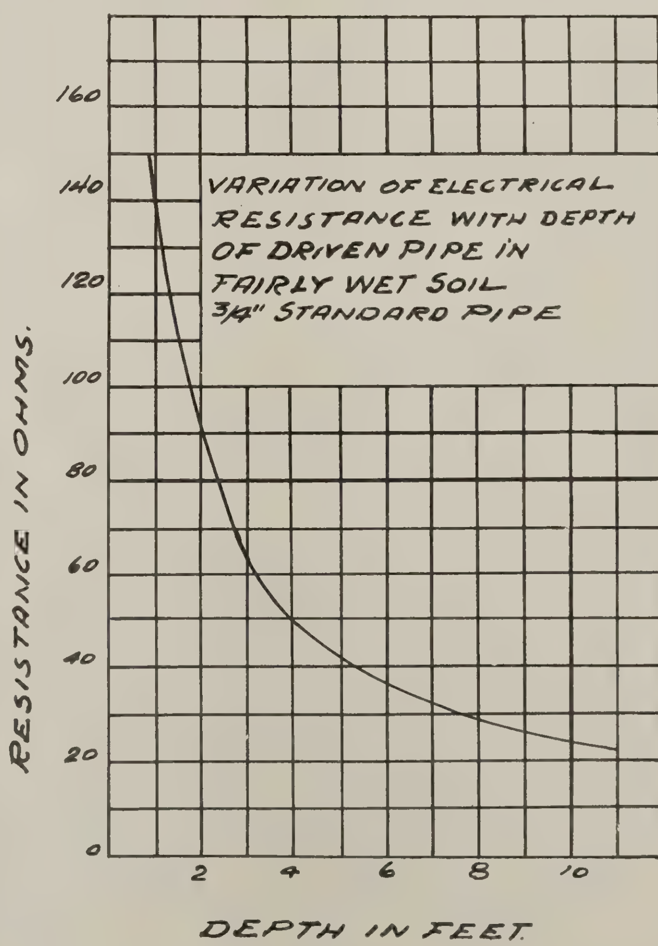


Fig. 3

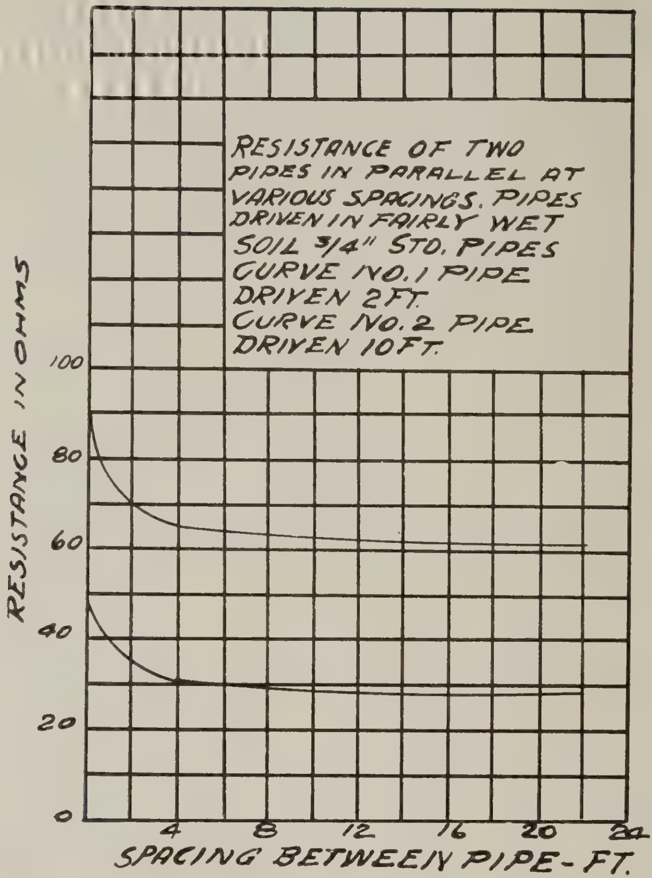


Fig. 4

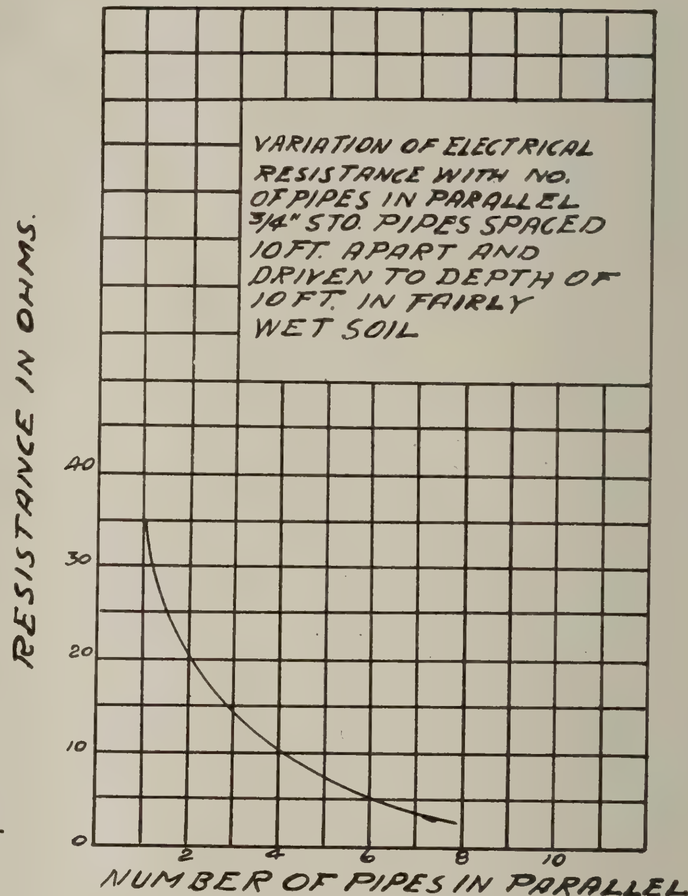


Fig. 5

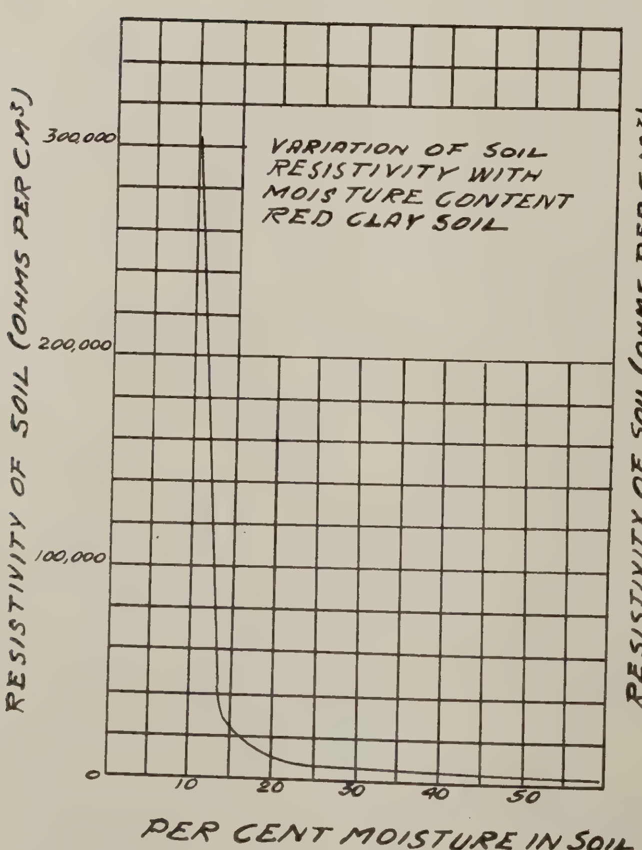


Fig. 6

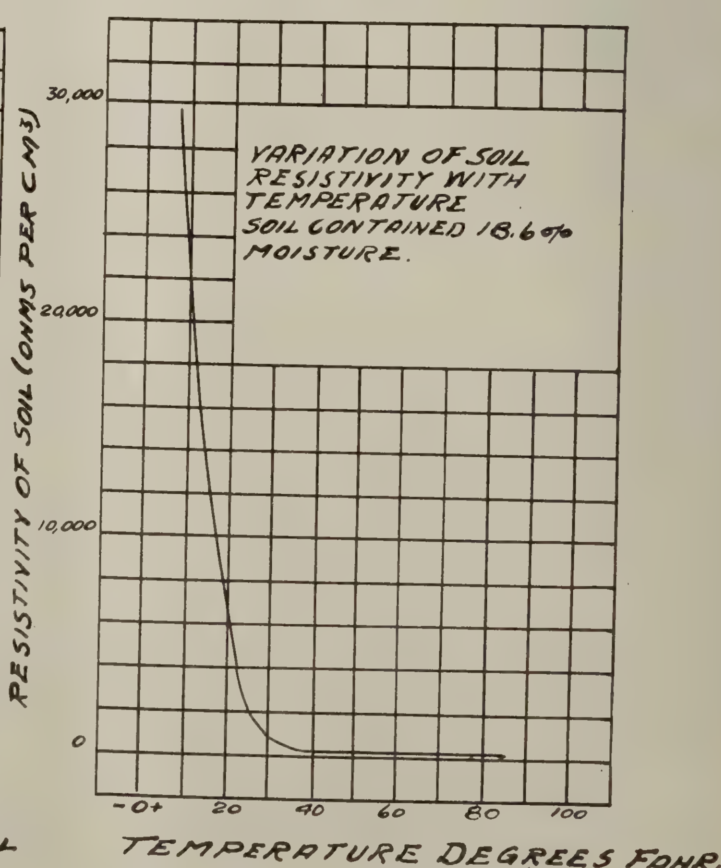


Fig. 7

to assure that a sufficient number of ground electrodes are used and that they are properly spaced.

Since the principal test of a ground connection is the resistance measurement, it will be discussed in greater detail. Resistance measurements should be made in all cases when grounds are first installed and at regular intervals thereafter. A record should be kept showing the exact location of the ground electrodes and connections to facilitate the tests. Due to the great effect of moisture and temperature on the resistivity of soil as shown in Appendix "A," the periodic resistance measurements should be made under extreme weather conditions, such as mid-winter or mid-summer.

In a multiple ground system with numerous ground electrodes, tests can be greatly facilitated by installing the electrodes and ground bus in such a way that the system can be sectionalized into small groups and resistance measurements made of the various groups. Unless a reference ground of known resistance is available it should be possible to split the ground system into at least three sections, so that the three-point method of measurement can be applied.

APPENDIX A

Characteristics of Ground Electrodes

A ground may be considered as a metallic conductor in a hemispherical mass of earth, as shown in Fig. 1, the radius of which will depend upon soil conditions. Assume that the outside or boundary of this hemisphere is earth at zero resistance and zero potential. The resistance of the ground connection is the resistance offered to the flow of current from A to B. This resistance consists of four parts, viz.: (1) that of the wire or connection to the ground electrode; (2) the resistance of the electrode; (3) the contact resistance between the electrode and earth, and (4) the resistance of the soil in the immediate vicinity. Unless a long wire is used and unless the electrode is of great length and small cross section, the first two parts of the total resistance will be negligible. Furthermore, the contact resistance between metal and earth, as determined by tests made at the Bureau of Standards, can also be neglected as far as practical purposes are concerned—a fact which has not been generally appreciated. The principal part of the resistance of a ground connection is in the soil surrounding the electrode, and it is for this reason that the resistance of a ground connection varies so greatly for different soils.

Pipe Grounds. The electrical characteristics of ground pipes have been definitely determined for general conditions in extensive tests conducted by the Bureau of Standards and others. Quantitative values on the resistance of pipe grounds may be summarized as follows:

(a) As shown in Fig. 2, the decrease in resistance with increased size of pipe is quite appreciable up to a pipe size of about one inch, beyond which the curve becomes quite flat. From the standpoint of resistance there is, therefore, no economy in using a pipe size larger than one inch. In exceptional cases, where pipes must be driven to a great depth, 1¼-inch or 1½-inch pipe may be preferable in order to withstand the strains incident to driving.

It has been found that from the standpoint of resistance no difference can be observed between pipe grounds made with ordinary pipe and galvanized pipe, provided the former has a clean surface presenting no grease or paint or other insulating coating. Rust on the surface of a ground pipe is of little or no account in increasing contact resistance, since rust is iron oxide, which is permeable to water and is of no greater resistivity than soils. The relation of pipe diameter to resistance of a driven pipe will also hold true for steel or copper-clad steel ground rods.

(b) As shown in Fig. 3, very little decrease in resistance is obtained by driving pipes to a greater depth than 10 feet, provided that permanent moisture level is reached at this point and that it extends below the frost line. Soil conditions in some localities are such that it is impossible to drive a pipe to a depth of 10 feet, but where at all possible a depth of at least 6 feet should be attained, because for a lesser depth the resistance increases very rapidly.

(c) As shown in Fig. 4, ground pipes should be spaced at least 6 feet apart in order to obtain the minimum resistance for two pipes in parallel. Fig. 5 shows the reduction in resistance affected by a larger number of pipes in parallel.

As previously stated, 90 per cent of the resistance of a pipe ground falls within a radius of 6 to 10 feet around the pipe. By using a spacing of at least 6 feet, each pipe is kept out of the dense

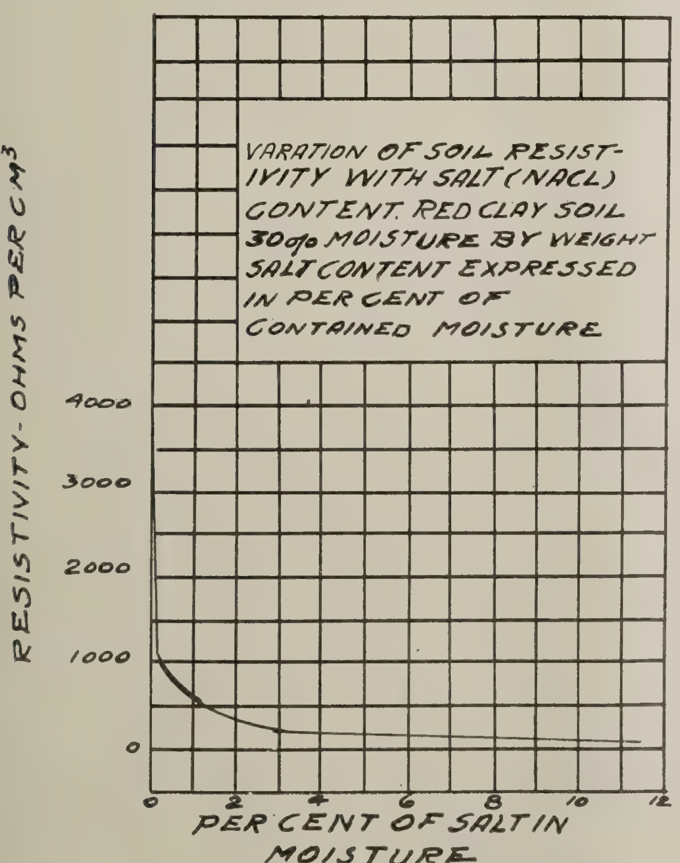


Fig. 8

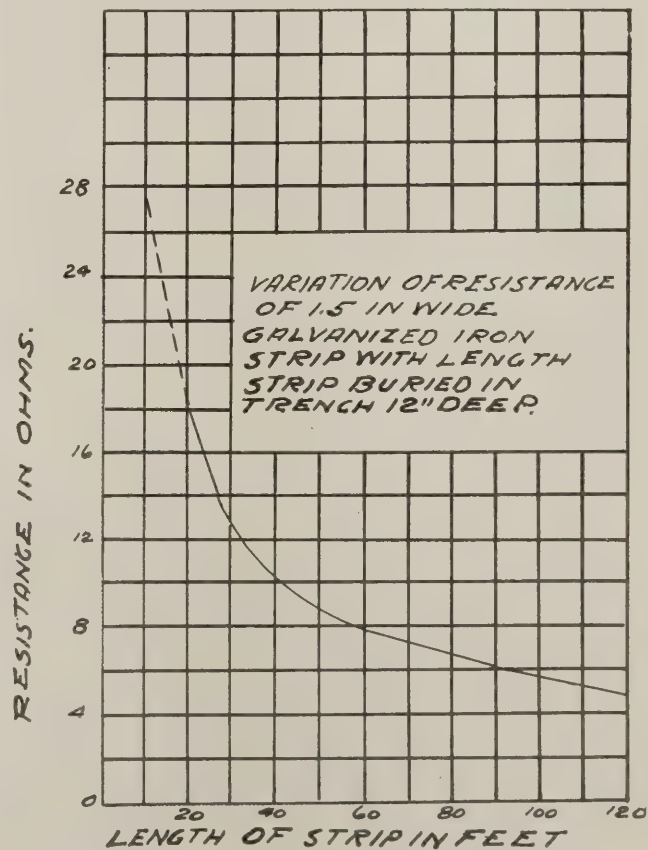


Fig. 9

current field of the other and a minimum resistance is obtained for the group of pipes as a whole.

(d) Fig. 6 shows very strikingly the effect of moisture content on the resistivity of soils. Above a moisture content of 20 per cent there is very little variation in soil resistivity with variation in per cent moisture in the soil. Below a 20 per cent moisture content the soil resistivity rises very abruptly as the curve shows, being thirty times as great with a 10 per cent as with a 20 per cent moisture content.

Since the normal moisture of soils ranges from 10 per cent in dry seasons to 35 per cent in wet seasons, with an approximate average of perhaps 16 to 18 per cent, it is of great importance that the effect of moisture in soils be fully appreciated.

(e) Fig. 7 shows the variation of soil resistivity with temperature. Above freezing, that is 32 deg. Fahr., it is noted that the effect of temperature is quite negligible. Below 32 deg. Fahr. the soil begins to freeze and introduces a tremendous increase in the resistivity of the soil as the curve shows, being fifty times as great plus 5 deg. Fahr. as at plus 32 deg. Fahr. This emphasizes the importance of installing ground electrodes well below the frost line. Where winters are very severe, this may be 6 or 7 feet below the surface.

(f) The electrical conductance of any soil is by means of the electrolytes formed by moisture combining with the soluble acids, alkalies and salts, and where they are lacking their artificial introduction will show excellent results, as indicated by curve shown in Fig. 8. It will be noted that the curve flattens off at about 3 per cent salt in moisture, and further increases of salt effect but little decrease in the soil resistivity. The effect of salt differs, of course, for different kinds of soil.

In this curve 1 per cent of salt in moisture represents 0.27 pounds of salt per cubic foot of soil, which will give an idea of the amount of salt required in treating a ground connection. As previously stated, 90 per cent of the resistance of a driven pipe lies within a 6 to 10 foot radius around the pipe. Therefore, assuming the pipe driven to a depth of 8 feet, the salt treatment should be applied to a cylinder of earth at least 12 feet in diameter and 8 feet deep or a cubic capacity of 900 cubic feet. To make a half of 1 per cent solution for a soil having a 30 per cent moisture content, therefore, requires 122 pounds of salt. In applying salt to a driven pipe, a basin about 2 feet in radius and 1 foot deep should be excavated around the pipe, the salt poured in and then covered with a layer of earth and flooded with water, which will dissolve the salt and carry it deeper into the ground. For average soil conditions it is estimated that the salt around driven pipes should be renewed every two years.

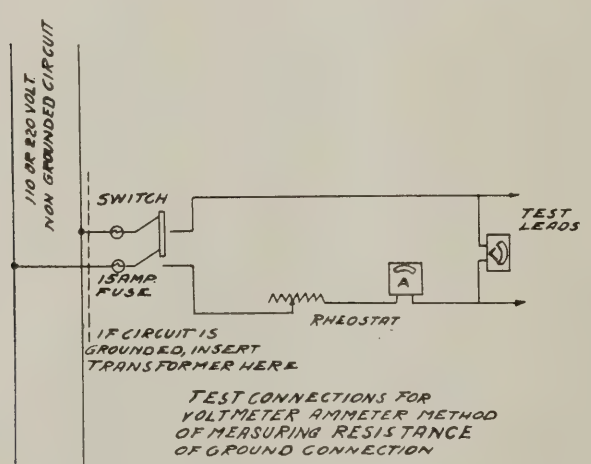


Fig. 10

Plate Grounds. Due to the greater difficulty and expense involved in installing plates for test purposes, the information on plate grounds is not as extensive as that available on pipe grounds.

In general it may be said that plates should be buried from 5 to 8 feet in conducting soil, since greater depths than these do not show a further marked decrease in resistance. There is also no economy in using a single plate of greater area than 20 square feet. Where two plates are used in parallel the minimum resistance for the two will be obtained where they are placed 25 to 30 feet apart.

The data on the effect of temperature and moisture content on ground resistivity given under pipe grounds, of course, also apply in the case of plate grounds.

Strip Grounds. Fig. 9 shows the relation between resistance and length of a strip ground. In burying a strip ground it is well to remember that for a given length of strip the wider the distribution the more effective the ground connection that will be obtained, which means that a strip should be buried in approximately a straight line. It appears from the data available on strip grounds that after a depth of 3 feet has been reached there will not be a further marked decrease of resistance with increasing depth.

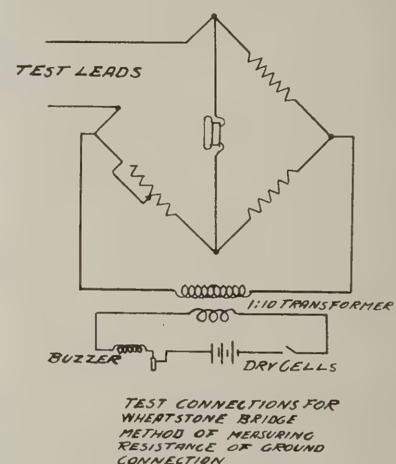


Fig. 11

References. Peters, O. S., Ground Connections for Electrical Systems. Bureau of Standards Technological Paper No. 108.

Towne, H. M. Lightning Arrester Grounds. Electrical World. Vol. 83, I p. 131-5, Jan. 19; II p. 183-7, Jan. 26, 1924.

APPENDIX B

Methods of Measuring Ground Resistance

There are a number of methods by which resistance measurements of ground connections can be made, the principal ones from the standpoint of practicability are:

(a) Voltmeter-ammeter method.
(b) Wheatstone Bridge method.

Voltmeter-Ammeter Method. This is the most reliable method of any for making resistance measurements, especially if alternating current is available. The equipment required and connection diagram are shown in Fig. 10. It will be noted that if the a. c. supply circuit is grounded a transformer is required in order to isolate the test ground from the ground on the supply circuit.

Where the resistance of only one ground connection is to be measured, there must be some auxiliary or reference ground either of known value or of negligible value to use in testing.

Where there are at least three grounds to be measured, a known auxiliary ground is not required. With the three grounds identified as *A, B* and *C,* the resistance of each ground can be determined by measuring the series of resistance of *A* to *B, B* to *C,* and *C* to *A,* and then solving the three simultaneous algebraic equations thus obtained.

The chief advantage of this method lies in the fact that comparatively high voltages and currents are used, and results are not affected by stray currents of any kind in the earth. The most accurate results are obtained when the individual ground connections all have approximately the same resistance.

The disadvantage of this method is that if a transformer is required, the outfit weighs so much that it is inconvenient to transport. Furthermore, it is limited in use to locations where a 110 or 220 volt supply circuit is available.

Wheatstone Bridge Method. The apparatus for this method consists of three dry cells in series, a four ohm buzzer, a push button, a very small transformer having about a 1:10 ratio, a Wheatstone bridge and a telephone receiver, all connected as shown in Fig. 11. The bridge should preferably be of the easily portable type used for field work. The telephone receiver should

be of rather low sensitivity so as to be less affected by the disturbing effects of stray currents.

In making measurements with the bridge method, the procedure is the same as for the ammeter-voltmeter method; that is, with three ground connections under test, the resistance of each pair in series is measured and the individual resistances obtained from the solution of the simple algebraic equations.

The results obtained by the bridge method are accurate within 5 per cent, which is sufficient for practical purposes.

The principal advantages of the bridge method of measuring the resistance of ground connections are as follows:

(a) The source of energy constitutes a part of the apparatus, so it is not necessary to depend upon a low voltage supply circuit for measuring purposes.

(b) The outfit is easily portable and very rugged.

(c) Direct readings are obtained, doing away with the need for computations.

The disadvantages of the bridge methods are that:

(a) The test fails if for any reason alternating currents are induced from external sources into the ground circuit, because the induced currents will make the telephone receiver too noisy to make an accurate balance of resistance.

(b) No indication is given of the stability of the ground connection to dynamic currents.

Note—The section from the end of the 5th paragraph in the 2nd column on page 173 to this point is reprinted from Serial Report of the Electrical Apparatus Committee (1925-1926), Technical National Section, National Electric Light Association, covering Practices and Methods in A. C. Substation Grounding, and is used by courtesy of the National Electric Light Association, 29 West 39th street, New York, N. Y.

Direct Current Distribution Systems. In three wire direct current systems the ground connections shall be made at the neutral at one or more supply stations.

In two wire direct current systems the ground connection shall be made at one station only.

No ground connection shall be made at individual services or within the building served. In two wire systems the grounded side of the circuit shall be insulated from ground except at the station ground connections.

Alternating Current Distribution Systems. In alternating current systems the ground connection shall be made at the building service by direct ground connection through water piping system or artificial ground.

Where transformers supply a common set of mains, fuses shall be located only at such points as not to cause the loss of the ground connections after any fuses in the transformer circuits or mains have been blown.

Alternating current secondary circuits supplied from a transformer outside the building shall not be grounded inside building except at the service entrance.

In single phase, three wire systems, the ground shall be on the neutral conductor. In single phase, two wire systems, the ground may be made on either conductor. In two wire, single phase and in two or three phase svstems the ground shall be made at that point of the system which brings about the lowest voltage from ground unguarded current-carrying parts of the connected devices. Where only one phase of a two or three phase secondary system is employed for lighting, that phase should be grounded, and at the neutral conductor if one is used.

The grounded conductor of an interior wiring system shall have but one grounding connection within the building.

The secondary system ground shall be separate from the equipment, conduit, armored cable, metal raceway.

Current in Grounding Conductor. Grounds shall be so arranged that under normal conditions of service there will be no objectionable flow of current over the grounding conductor.

Where the objectionable flow of current over a grounding conductor is due to the use of multiple grounds, one or more of such grounds shall be abandoned or the location changed.

Equipment and Wire Runways. For conduit, metal raceways, generators, motors, transformers, and other equipment, the point at which the grounding conductor is attached shall, if practicable, be readily accessible.

No separate grounding conductor shall be required for non-current-carrying parts of equipment if grounded through the conduit, cable sheath, or metal raceways system of the building by means of standard locknuts and bushings or by a separate bond between the equipment and the conduit, or metal raceway system. The wiring shall conform to all requirements of the specifications applying to wires of the voltage of the circuit to which the grounding wire is attached.

For conduit or metal raceways the ground connection shall be as near as practicable to the point where the conductors in the conduit system concerned receive their supply.

Service Conduit. Where the service conduit is grounded, its grounding wire shall be run directly from it to the ground, no portion of the house conduit being used as a part of the grounding conductor.

Material and Continuity. In all cases the grounding conductor shall be of copper or of other metal which will not corrode excessively under the existing conditions and, if practicable, shall be without joint or splice. If joints are unavoidable they shall be made and maintained so as to conform to the resistance requirements of rules under ground resistance.

In no case shall a fuse or automatic circuit-breaker be inserted in the grounding conductor or connection except in a ground connection from equipment where its operation will result in the automatic disconnection from all sources of energy of the circuit leads connected to equipment so grounded.

For lightning arresters and ground detectors the grounding conductor shall be as short and straight as practicable and free from sharp bends.

Size and Capacity. The conductor, or conductors, for grounding circuits shall have a combined current capacity sufficient to insure the continuity and continued effectiveness of the ground connection under conditions of excess current caused by accidental grounding of any normally ungrounded conductor of the circuit. No individual grounding conductor for electrical circuits shall have current capacity less than that of a No. 8 (0.128 inch) copper wire.

The grounding conductor for a direct current system shall have a current capacity not smaller than the largest feeder of the same system leaving the station.

The grounding conductor for alternating current systems shall have a current capacity not less than one-fifth that of the conductor to which it is attached, except that it need not be larger than No. 0 (0.325 inch) copper.

For lightning arresters the grounding conductor, or conductors, shall have a current capacity sufficient to insure continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual grounding conductor shall have less conductance than a No. 6 (0.162 inch) copper wire. The conductor grounding a lightning arrester shall not be connected to an artificial ground provided for circuits or equipment, but shall be kept at a distance of at least 20 feet when practicable.

For non-current-carrying parts of electrical equipment the conductance of a grounding conductor shall be not less than that provided by a copper wire of the size indicated in the following table. When there is no fuse or automatic circuit-breaker protecting the equipment, the size of the grounding conductor will be determined by the design and operating conditions of the circuit.

Rating of Fuse or Circuit Breaker Which Protects Equipment or Conductors

	Size of grounding copper wire	
	A. W. G.	Inches
Not more than 100 amperes	10	0.102
More than 100, but not more than 200 amp	6	0.162
More than 200, but not more than 500 amp	4	0.204
More than 500, but not more than 600 amp	2	0.258

Fusing Current Copper Wire (Amperes)

Size of wire	0000	000	00	0	2	4	6	8	10
Fusing current	3196	2684	2264	1895	1342	942	666	471	328
Size of wire	12	14	18	....	....	...	...	...	...
Fusing current	235	166	83	....	....	...	...	...	...

Fusing Current Aluminum Wire (Amperes)

Size of wire	0000	000	00	0	2	4	6	8	10
Fusing current	2367	1987	1676	1403	994	698	493	349	243
Size of wire	12	14	18	....	....	...	...	...	...
Fusing current	174	123	61	....	....	...	...	...	...

In portable cord to portable equipment protected by fuses not greater than 15 amperes capacity, a No. 18 (0.040 inch) grounding wire may be used.

Grounding wires for conduit, or metal raceway systems shall have a conductance of at least equivalent to No. 10 (0.102 inch) copper where largest wire contained is not larger than No. 0 (0.325 inch) and need not be larger than No. 4 (0.204 inch) where the largest wire contained is larger than No. 0; and for service conduit the grounding wire shall have a conductance not

less than that of No. 8 (0.128 inch) copper wire and need not be larger than No. 2 (0.258 inch) where the largest wire contained is larger than No. 0.

Mechanical Protection and Guarding Against Contact. Where exposed to mechanical injury the grounding conductor shall be protected by substantial conduit or other guard. Guards for lightning arrester grounding conductors shall be of non-magnetic material unless the grounding conductor is electrically connected to both ends of the guard.

If the resistance of the ground connection is in excess of three ohms, the grounding conductor, except in rural districts, shall be protected and guarded by being enclosed in insulating conduit or moulding to protect persons from injury by coming in contact with it.

Note—Such a high resistance may exist where artificial grounds are necessarily permitted in lieu of the preferable grounds to buried metallic water piping systems.

Mechanical protection and insulating guards should extend for a distance of not less than 8 feet above any ground, platform, or floor from which grounding conductors are accessible to the public.

A grounding conductor for a circuit shall be guarded as required for current carrying conductors of the circuit.

Exceptions.—(1) A grounding conductor for a circuit having multiple grounds, where such conductor is entirely outside buildings and has strength and current capacity not less than No. 6 (0.162 inch) copper wire.

(2) In stations substantial bare ground busses may be used.

Underground. Wires used for grounding conductors if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken, and shall have joints carefully painted or otherwise protected against corrosion.

The ground connection shall be permanent and effective, and be made as indicated below, but always to water piping systems, if available.

Piping Systems. For circuits, equipment, and arresters at supply stations, connections shall be made to all available active metallic underground water-piping systems between which no appreciable difference of potential normally exists, if the pipe is of sufficient capacity, and to one such system of appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system, if available. Gas piping should not be used for ground circuits.

Note—The protective grounding of electrical circuits and equipment to water pipe systems in accordance with these rules should always be permitted, since such grounding offers the most effective protection to life and property and is not injurious to the piping systems. Ground connections from circuits should not be made to jointed piping within buildings, except water piping.

Alternate Methods. Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. In many cases metal well casings, local metal drain pipes, and similar buried metal structures of considerable extent will be available and may be used in lieu of extended buried water piping systems.

In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other non-current-carrying surfaces should also then be connected. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require artificial grounding for steel frame buildings supported on masonry or concrete footings.

Artificial Grounds. When resort must be had to artificial grounds, their number should be determined by the following requirements:

(1) Not more than one such ground is required for lightning arresters, except where for large current capacity.

(2) At least two grounds are required for low voltage alternating current distribution circuits at transformers or elsewhere.

Grounds to Railway Returns. Protective ground connections should not be made to railway negative return circuits when other effective means of grounding are available, except ground connections from electric railway lightning arresters.

When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a grounded neutral with multiple grounds) between the railway return and the other grounded conducting bodies (such as buried piping and cable sheaths).

Note—This rule does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative return circuits for the prevention of electrolysis.

Multiple protective ground connections from other circuits to railway returns should be avoided, and where multiple artificial grounds are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, which flow would reduce their effectiveness, or otherwise cause damage.

Piping. Ground connections to metallic piping systems shall be made (except as permitted below) on the street side of water meters, which might interrupt the continuity of the underground metallic pipe systems, but connections may be made immediately inside building walls to secure accessibility for inspection and test. When water meters are located outside buildings or in concrete pits within buildings where piping connections are embedded in concrete flooring, the ground connections may be made on the building side of the meters.

Ground connections for equipment, or metal raceways, and the like, or as a multiple ground for alternating current secondaries, may be made to the water piping system at a point near the part to be protected, provided there are no insulating joints or fittings in the pipe to prevent a good ground. In such cases care should be taken to electrically connect all parts of the piping system liable to create a hazard (if they become alive) and the pipe system shall be shunted where necessary around meters, etc., in order to keep the connection with the underground piping system continuous.

Gas piping systems within buildings should not be used for purposes of this rule, except that gas pipe need not be insulated from otherwise well grounded electrical fixtures, and where the making of another ground connection for a fixture would involve a long run and the fixture is, therefore, of course, not within reach of plumbing or plumbing fixtures, the gas piping may for small fixtures be utilized as the sole ground connection. Where gas piping is so used it must be bonded to the water piping system at the point of entrance of water piping.

Ground Clamps. The ground connections to metallic piping systems shall be made by means of an approved clamp firmly bolted to the pipe after all rust and scale have been removed, or by means of a brass plug which has been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or by other equivalent means.

The grounding conductor shall be attached to the clamp or to the plug by means of solder or by an approved solderless connector. The point of connection shall be as readily accessible as possible, and the position should be recorded.

Note—With bell-and-spigot-joint pipe it may be necessary to connect to several lengths where circuits or equipment of large current capacity are being grounded.

Contact Surfaces. If conduit, couplings, or fittings having protective coating of nonconducting material, such as enamel, are used, such coating shall be thoroughly removed from threads of both couplings and conduit and such surfaces of fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Grounded pipes shall be free from rust, scale, etc., at the place of attachment of ground clamps.

In ice houses, packing plants, etc., where a great deal of moisture is present and where conduits are attached to metal cabinets, cut-out, pull or junction boxes, compensators, etc., by means of standard locknuts and bushings, these conduits should be bonded together with approved ground clamps.

Artificial Grounds. Artificial grounds should be located where practicable below permanent moisture level. Areas where ground water level is close to the surface should be used when available.

Where copper ground plates are used, they should be at least 0.06 inches thick. When driven pipes are used, they should be of galvanized iron and not smaller than three-fourths inch internal diameter, and when cast-iron plates are used they should be at least 0.25 inches thick.

Limits. The combined resistances of the grounding wire and the connection with the ground shall not exceed 3 ohms for water pipe connections nor 25 ohms for artificial (buried or driven) grounds. Where it is impracticable to obtain with one ground, artificial ground resistance as low as 25 ohms, this requirement shall be waived, and two artificial grounds, at least six feet apart and with combined area of not less than four square feet, shall be provided.

Grounding Conductors. Grounding conductors from equipment and circuits of each of the following classes, when required by these rules, shall be run separately to the ground:

(1) Lightning Arresters.

(2) Secondaries connected to low voltage lighting or power circuits.

(3) Secondaries of current and potential instrument transformers and cases of instruments on these secondaries.

(4) Frames of direct current railway equipment and of equipment operating in excess of 150 volts and which is accessible to other than qualified persons.

(5) Frames of utilization equipment or wire runways other than covered by item (4), except that if a secondary distribution system has multiple grounds to water piping, service conduits may utilize the same grounding conductors.

(6) Lightning Rods.

Arrester Grounds. Lightning arrester ground connections shall not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipment, but should be well spaced and, where practicable, at least 20 feet from other artificial grounds.

Location. Where required, lightning arresters shall be attached to all undergrounded sides of system connected to overhead circuits except circuits in cables with grounded metal sheath.

Indoors. Lightning Arresters with auxiliaries, when installed inside of buildings shall be located well away from all other equipment, passageways, and combustible parts of buildings. When of a type containing oil the necessary safety precautions depend largely on whether they are located in buildings or outdoors.

Air Break Disconnectors. Lightning arresters on circuits of more than 7,500 volts shall be so arranged, isolated, and equipped that they may be readily disconnected from conductors to which they are connected by air-break manual disconnectors, having air gaps of not less than four times the equivalent needlepoint sparking distance in air of the operating voltage of the circuit to which the arresters are connected, and never less than eight inches.

These disconnecting devices should be installed at a sufficient distance from all parts of the arrester equipment to make it safe to perform maintenance and inspection work on any part of the arrester.

Working Space. Such disconnectors, unless remotely controlled and operated, shall have adequate and readily accessible working space with secure footing, which shall be maintained about all electrical parts or equipment which require adjustment or examination when exposed while in service.

Ground wires shall be run as directly as possible and shall be of low impedence and ample current capacity.

Kinks, coils, and sharp bends in the wires between the arresters and the outdoor lines shall be avoided as far as possible.

All non-current-carrying metal parts of arresters shall be grounded unless effectively isolated by elevation or guarded as required for live parts of the voltage of the circuit to which the arrester is connected.

Protection from Contact or Arcing. All current-carrying parts of arresters or circuits of more than 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them or from injury by arcing.

Making Adjustments. Lightning arresters, unless provided with disconnectors which are always opened before work is done on the arresters, shall be so arranged that necessary adjustments are possible (without approach to current carrying parts) through the use of permanently grounded mechanism or suitable insulating appliances. Where charging or adjustment must be done with arresters alive, permanently grounded mechanisms or suitable insulating appliances shall always be provided.

Insulation of Attachments. All choke coils, gap electrodes, inherent to the lightning protective equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

Respectfully Submitted,
COMMITTEE ON SAFE
INSTALLATION AND MAINTENANCE
OF ELECTRICAL EQUIPMENT.

Progress Report of Committee on Loose Leaf Manual

Committee:—

L. S. Billau, chairman, assistant electrical engineer, Baltimore and Ohio; J. A. Andreucetti, assistant electrical engineer, Chicago & Northwestern; G. H. Caley, electrical and signal engineer, New York, Ontario & Western.

TO THE MEMBERS:

Due to unavoidable causes the publishing of the "Manual of the Association of Railway Electrical Engineers" covering the recommended practices, standards, specifications, etc., of the association has been delayed, but it is now expected to distribute it within the next few weeks. Detail information pertaining to the distribution of the Manual will be sent to the members by Mr. J. A. Andreucetti, secretary-treasurer.

The work of the committee this year will consist in working out the details of the methods to be followed in keeping the Manual permanently up-to-date. In this connection each committee shall include as part of its regular work each year, commencing with their reports to be submitted this fall, the following pertaining to the subjects handled by the committees.

(a) Specific recommendation covering new subject matter, pertaining to recommended practices, specifications, etc., that should be added to the Manual.

(b) Recommendation as to what changes, if any, should be made in the subject matter already covered in the Manual, pertaining to its work.

(c) Recommendations as to what obsolete or superseded matter should be withdrawn from the Manual, if any.

If the work of a committee has been such that it has nothing to add to the Manual it should be so stated in the report of that committee.

Respectfully submitted,
COMMITTEE ON LOOSE LEAF MANUAL.

Progress Report of Committee on Motors and Controls

Committee:—

G. W. Bebout, chairman, electrical engineer, Chesapeake & Ohio; T. W. Wigton, assistant electrical engineer, Chicago, Burlington & Quincy; A. E. Ganzert, electrical supervisor, Chicago, Rock Island & Pacific; G. T. Goddard, general foreman electrician, Illinois Central; T. A. Johnson, electrical engineer, Central of Georgia.

TO THE MEMBERS:

Your committee has had two meetings at Chicago, one to outline the work for the individual members and to plan further studies of new developments in motors and controls, March 8. Another to determine the progress being made, May 8.

Your Committee is seeking all information available on the subject, and studying the new applications with reference to making any changes or additions to the report submitted two years ago.

Some special equipment has been developed and put on the market since the last report that will be handled in our report next October.

Double wound rotors of AC induction motors for across the line starting.

Various across the line type starters.

DC operated control panels for large AC motors.

Synchronous motors and special motors for power factor correction and air compressor drive.

Multiple speed AC motors for variable speed machine tool and stoker drives.

Our motor specification will be changed to avoid the necessity of special equipment having to be built for railway service, and to more nearly agree with the A. R. E. E. specifications.

Recommendations will be made on the proper type and size motors to use for various purposes.

Respectfully submitted,
COMMITTEE ON MOTORS AND CONTROL EQUIPMENT.

Progress Report of Committee on Illumination

Committee:—

L. S. Billau, chairman, assistant electrical engineer, Baltimore and Ohio; J. E. Gardner, electrical engineer, Chicago, Burlington & Quincy; G. T. Johnson, assistant electrical engineer, New York, New Haven & Hartford; J. L. Minick, assistant engineer, Pennsylvania railroad.

To the Members:

The program of work for the Committee on Illumination for this year covers the following:

Compilation of information showing production of incandescent lamps in train lighting and headlight schedules, segregated as to sizes, voltages, types of bulbs, etc., corresponding to similar data that has been compiled in the past for train lighting lamps and which will now be extended to include lamps for locomotive service.

To continue the study of the subject of flood lighting as applying to railroad classification yards, with particular reference to the requirements to be met where mechanical car retarder system of yard operation is used.

The committee was also directed to look into the matter in conjunction with the lamp manufacturers of providing a suitable method of marking the headlight lamp bulb used for switching locomotive service to permit readily distinguishing it from the 250 watt, P-25 headlight lamp for road locomotive service. The committee hopes to be in position to submit definite recommendations on this subject in the report to be submitted at the annual convention.

Your committee will be glad to receive suggestions from the members in connection with the above subjects or other matters coming within the jurisdiction of the work of this committee.

Respectfully submitted,

Committee on Illumination.

Progress Report of Committee on Train Lighting

Committee:—

P. J. Callahan, chairman, supervisor car and locomotive electric lighting, Boston & Maine; L. S. Billau, assistant electrical engineer, Baltimore & Ohio; F. J. Hill, chief electrician, Michigan Central; J. L. Minick, assistant engineer, Pennsylvania; A. E. Voigt, car lighting engineer, Atchison, Topeka & Santa Fe; G. W. Wall, department electrical foreman, Delaware, Lackawanna & Western; R. E. Gallagher, assistant electrical engineer, Louisville & Nashville; F. O. Marshall, assistant superintendent yard service, Pullman Company.

To the Members:

Your Committee on Train Lighting submits the following progress reports on subjects which have been and are being considered.

Size of Wire for Battery Circuits.—By reducing the voltage drop between battery and lamp circuit, it is possible where Edison batteries are used, to reduce the number of cells from 25 to 24, and obtain the same voltage at the lamp as previously obtained.

Your committee, therefore, recommends that this voltage drop be limited to ½-volt for normal lamp load. With the possible exception of dining cars and official cars No. 2-AWG wire for main battery circuit and battery connectors would be of sufficient size to accomplish this result, and the committee therefore recommends this size wire for general practice.

Bolt Clearance.—The clearance table as given in Volume 9, Proceedings of 1916, is being studied with a view to increasing the clearance limits which are possible with modern car and truck construction, in which connection the committee submits the following revision of this table for comment.

Sect. 3. Par B. Truck supported. Over end sill 3 in. Over brake beam 3 in. Under brake beam 2½ in. Any other part of car body or truck 1 in.

Body supported. Over end sill 3 in. Over brake beam 3 in. Under brake beam 2½ in. Any other part of car body or truck 1 in. With belt in position for maximum curvature over which car is designed to operate, clearance between belt and brake release spring shall not be less than 1 in.

Steam drips to be located on opposite side of car from generator, and at least 5 ft. from generator.

Rubber-covered Dynamo Pulleys.—Reports relative to the operation of this type of pulleys are inconclusive, and it is therefore felt that more information must be obtained before a definite recommendation can be made relative to this type of pulley construction.

It is desired that railroads experimenting with this pulley, acquaint this committee with the results of their experiments at an early date, in order that as complete information as possible may be compiled for annual report.

Axle Generator Axle.—Recommended that a rough-turned axle be used for mounting axle pulleys, to avoid possibility of eccentric or loose mounting of pulleys.

General Support.—Your committee in looking into the subject of developing a generator support which will provide for interchangeability in the application of axle generators.

Pulley Centers.—It is recommended that distance between center of dynamo and axle pulley for body hung generators, be not less than 6 ft. in order that belt life be increased through greater friction and lesser necessary tension.

Locomotive Train Lighting.—There is an increasing interest in locomotive train lighting as applied to suburban and branch line service. Your committee is compiling detailed information relative to this system as it is being developed by the different railroads, and plans to present in the annual report a statement covering a number of locomotives and cars equipped, etc.

The committee will also submit recommendations covering the best practices as thus far developed.

Respectfully submitted,

Committee on Train Lighting.


Interiors of the Wabash's "Banner Blue Limited"

Water Tower and Power House

The Macon Shops of the Central of Georgia

Complete Electrification of All Shops on System Establishes Precedent for Other Progressive Roads

ONE of the finest locomotive repair shops in the country is that of the Central of Georgia, located at Macon, Ga. While these shop buildings are not new, much of the machinery contained in them is of the most modern character and even the buildings themselves, although erected in 1907, could scarcely be improved upon if they were to be built today.

The Central of Georgia is probably the most progressive road in the country from the standpoint of utilization of electrical energy in repair shops and recently the last shop on this system was converted from steam to electric drive, including air compressors. Large sums of money have been expended already and more will be spent during the present year to replace obsolete machine tools. The Macon shops are devoted almost exclusively to locomotive and freight car repair work, while passenger car work is taken care of at Savannah.

The next largest shop on the system is that at Columbus, Ga., which is a modern shop in every respect. Smaller running repair shops are located at Cedartown and Savannah, Ga., while a complete new terminal including mechanical facilities is under construction at Albany, Ga. The unique feature about all of the equipment in these shops is that about 90 per cent of the tools are driven by individual motors.

Power Supply

Although the Macon shop is equipped with standby steam generating machinery, this is only used as emergency and power is purchased at the average rate of 11½ mills per kw. hr. At Atlanta, Columbus, Cedartown and Macon, the power supply is hydro-electric, while at Savannah steam power is used to generate electrical energy, the steam being produced by fuel oil. The standard voltage used throughout the system is 440 volts a.c., 3-phase, 60-cycle, and where direct current is desired for variable speed, 220 volts is used, this being derived from a centrally located synchronous motor-generator set.

At Macon, the primary voltage of the power company's lines is 6,600. This is stepped down through a bank of three 500 kva. transformers to a secondary voltage of 440.

On the secondary side it is possible to change from closed delta to open delta and cut out any transformer through an arrangement on the switchboard without disturbing the wiring which permits operation of two transformers in open delta at 8,770 in case of damage to any of the transformers.

The standby generating equipment previously mentioned consists of three turbo-generators, one 500 kw., one 300 kw., and one 625 kva. These generate current at 440 volts a.c., 3-phase, 60-cycle, and are used only in the event of failure of purchased power.

The main air compressor equipment consists of one unit 1,640 cu. ft. synchronous motor driven, one 1,000 cu. ft. unit, induction motor driven, and one cross compound steam driven unit with a capacity of 2,000 cu. ft. The electrical machines are normally used and the steam machine held in reserve.

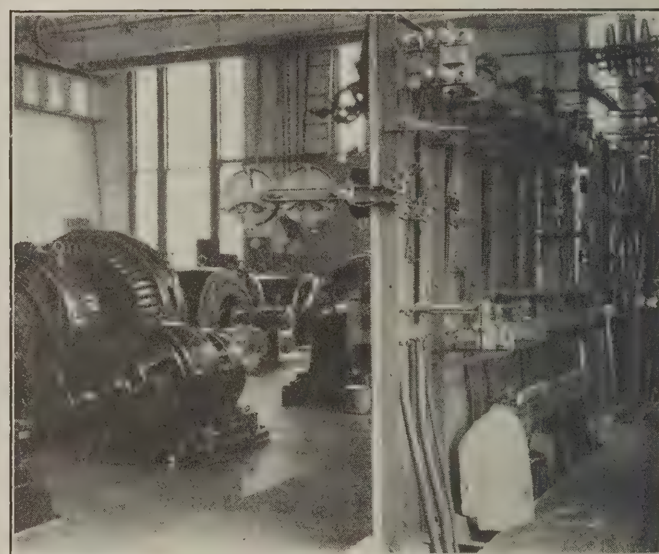
Power Distribution

Each department is connected to a panel on the switchboard and from these panels power is distributed throughout the shop. Originally, all circuits for power of lighting were run under ground, but for the past three years the lines have been run overhead through the shops on saddle brackets, pins and porcelain insulators. This change has relieved considerable trouble which had been experienced due to the wiring becoming grounded. The lines run down each side of the shop in parallel, consisting of 500,000 circular mill cables on the a.c. lines and 500,000 circular mills on the d.c. lines. These lines run a distance of 522 ft. and the corresponding lines are tied together through tie switches to balance the load at each end of the building.

Where Electrical Energy is Received at 6600 Volts and Stepped Down to 440 Volts

Equipment

Recently, modern machinery has been installed in the blacksmith shop, boiler shop and roundhouse. Other departments have also been supplied with new machines and some of this equipment is being installed at the present time.



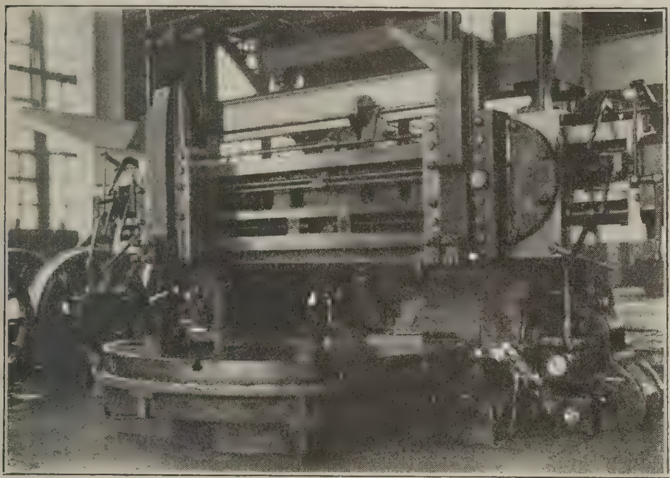
Interior of the Power House Showing Rear of Switchboard

Among the new equipment are three Westinghouse portable welding machines. One of these has a capacity of 200 amperes and the other two a capacity of 250 amperes each. Five Berwick rivet heaters have been found to be a great improvement over the old oil furnaces, and

View in the Machine Shop

have made it possible to show a marked increase in production.

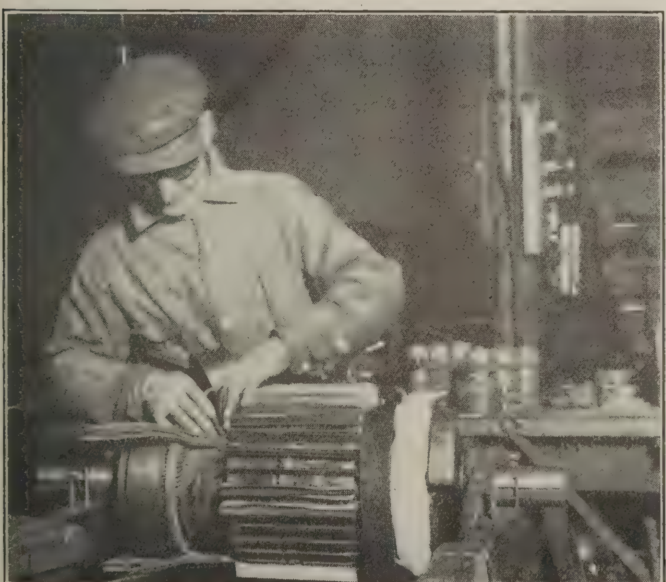
A modern turntable, 100 feet in length, of the three point suspension type, driven by a.c. motors, one on each end, forms an important part of the outside equipment. All of the cranes in the shop have recently been equipped with Youngstown limit switches in order to keep the blocks from jamming which might otherwise result in injury to persons or equipment.



A 102" Boring Mill Driven By a 220 Volt D. C. Variable Speed Motor, Automatic Push Button Control

Maintaining Electrical Equipment

In the Macon shops there are 387 motors ranging in size from ¼ to 427 hp. and these operate on 220 volts d.c. and 440 volts a.c., 3-phase, 60-cycle. This equipment is maintained altogether in the shop and has not been found necessary to go outside for anything. The maintenance of these motors are done along with the system equipment, as all the winding for the entire system is done at the Macon shops.



An Armature Winder at Work

The shop equipment is inspected at 30-day intervals. Accumulation of dust and dirt is blown from the windings and bearings tested. Twice a year the old oil is removed, the bearings flushed with gasoline and new oil applied.

There are 11 overhead cranes in the shop ranging from 10 to 150 tons capacity which are equipped with the Westinghouse type K motors and Allen Bradley controllers. These cranes are inspected every month and reports are filled out and signed by the operator, electrician and machinist who makes the inspection. It has been found that this practice prevents trouble from any of the appliances on these cranes which might cause personal injury.

In case of failure to the equipment, inspection is first made by an electrician and then by the chief electrician in which numerous tests are made to determine the cause of the failure. The machine is next checked up to find the amount of work on hand for this machine to do, and whether or not this work can be done on other machines while the motor is undergoing repairs. If it is found that congested conditions exist at the machine, the armature winder goes to the machine and if possible cuts out the damaged coil, takes the form number of the machine, maker and type, and then proceeds to manufacture a set of coils. Insulation is cut and everything is put in readiness to catch this motor for rewinding when the machine is not congested.

Operating the Coil Forming Machine

By closely checking the bearings and seeing that they are properly oiled and that no excess oil is allowed to drip down into the windings to soak the insulation, it has been possible to reduce the motor failures about 50 per cent from what they formerly were when close methods of inspection were not followed.

At intervals of three months all of the starting equipment is gone over to see that the dash pots have sufficient oil in them, and at this time the current settings are properly adjusted in order to give the motor a maximum amount of protection.

Coil Construction

In caring for so large a number of motors as is done at Macon, there are necessarily a great many coils wound

and the practice followed in manufacturing these is of interest.

The loops are wound and shaped and then dipped in No. 311 Westinghouse amber varnish for a period of from

CENTRAL OF GEORGIA RAILWAY COMPANY

Weekly inspection of shop cranes.

Crane No.____ Location____ Date____ 192__

Are limit switches so adjusted that they will cut off in time to prevent blocks jamming against housing when hoisting at full load? ____

Are brakes properly adjusted? ____

Are controllers in good servicable condition? ____

Is all wiring clear of grounds? ____

What is the condition of the cables and trimmings? ____

Were the brakes and limit switches tested by actually operating crane? ____

Are there any defects, electrical or mechanical in the equipment that might effect the safe operation of the crane. (No)____ (Yes)____ If yes describe them.

____Machinist

____Electrician

____Crane Operator

R-E-M-A-R-K-S

Record of Weekly Shop Crane Inspection is Made on This Form

five to ten minutes in order that the varnish may thoroughly impregnate them. They are then removed and placed in a baking oven for a period of eight hours.

The oven used for this purpose is a shop made oven,

MOTOR REPAIR RECORD.

File No.____ Date____

Shop Order No.____

Received from____ Operating____
Shop____ Shop No.____
Name of Builder____ A.C. or D.C.____
Type____ Frame No.____
Style No.____ Serial No.____ Field Serial No.____
H.P.____ Volts____ Amp.____ R.P.M.____ Cycles____
Phase____ Winding____ Shaft Marks____
No. Commutator Bars____ Commutator connected 1 &____
No. Slots____ Kind of Slots____ Width____ Depth____
Coils laid in slots 1 &____ No. Coils____ Size Wire____
Kind of wire____ No. turns per coil____ No. wires in parallel____
No. Circuits per coil____ Loop Winder Set____
Coil Spreader Set____
Stator connected____ No. Poles____
Kind of Rotor____ Connected____
Kind of Slots____ No. Coils____ Size Wire____
Kind of wire____ No. turns per coil____
No. wires in parallel____ No. circuits per coil____
Coils laid in slots 1 &____ Loop winder set____ Coil spreader set____
Repairs completed____
Repairs made by____
Cost____ Material____ Labor____ Shop Expense____
Remarks____

Bottom Leads____
Top Leads____

Under heading of "Remarks" explain briefly nature of repairs made. Foreman will fill in two copies keeping one for his file and mail one copy promptly to the Electrical Engineer, Savannah, Georgia.

____Foreman.

Two Copies of this Form are Made Out—One Kept by Foreman and One Filed in the Office of the Electrical Engineer

cubical in shape, having about four feet at each dimension. It is made of jacket iron, lined with asbestos and heated with four Westinghouse ribbon heaters controlled by a shop made thermostat which is remarkably accurate.

After the coils have been removed from the oven they are ready to be applied to the armature or stator as the case may be.

In extreme emergency, coils may be dipped in air drying varnish which permits them to be dried much quicker than with baking varnish and makes it possible to put the machine into service much sooner. In this case, the work on the machine involved is speeded up until the production is considerably ahead of the demand and when this has been accomplished, the motor is again removed from service at a convenient time and submerged in baking varnish and put into the oven. Usually this is done on Saturday and the baking process is allowed to continue for 12 hours so that the motor may be reinstalled on Monday morning.

Practice in handling many motors has resulted in an ability to do the work very quickly if necessary and if the

DIRECT CURRENT MOTOR REPAIR RECORD.

File No.____ Date____

Machine No.____ At____
Manufactured by____ Type____
Style____ Serial No.____
Location____ Driving____
No. coils____ No. Commutator Bars____
Operating Voltage____ Volts delivered____
Coils lie in lots 1 &____ Commutator Pitch 1 &____
No. of poles____ Has machine inter poles____
Bottom Leads____ Top Leads____
Fields wound shunt____ Series____ Comp.____
Loop Set____ Spreader H____ T____ B____
Current drawn normal operation____ Amps.
No. wires parallel____ No. Turns____

Size wire B & S____ No. coils per bundle____
Operating Characteristics____
Horse Power____ Amperes____ RPM____
Size of Shaft____ Diameter of pulley____
Bearings____ Driving side____ Off side____
No. Brushes____ L____ W____ T____
Can be substituted for____ By____
Brushes manufactured by____ No.____
Cause of failure____
Give details____

Removed from service____ Returned____
Replaced by Motor No.____
Nature of Repairs____

Repairs made by____ Inspected by____
Kind of control____
Type____ Style____ Serial____

Form Used in Keeping Record of Direct Current Motor Repairs

occasion demands, it is possible to remove a small d.c. armature, such as would be used on one hp. machine, take off the old coils and apply new ones, paint, test, dip and put into the baking oven in two hours and fifty minutes and have the armature ready to be returned to service on the following morning. Practically every kind of winding work is done from the smallest fan motor armature to rotary converters, transformers, lift magnets, etc.

In order to carry on such extensive winding work, rather a large stock of material is kept on hand. Magnet wire from No. 36 to No. 00 and varnish cambric are stocked.

Working Force

The inspection for maintenance work at Macon is carried on with a force of four electricians, or if the power plant operation is included, nine electricians. The rest of

the force consists of two specialists and five apprentices. The specialists rate between the apprentice and the electricians.

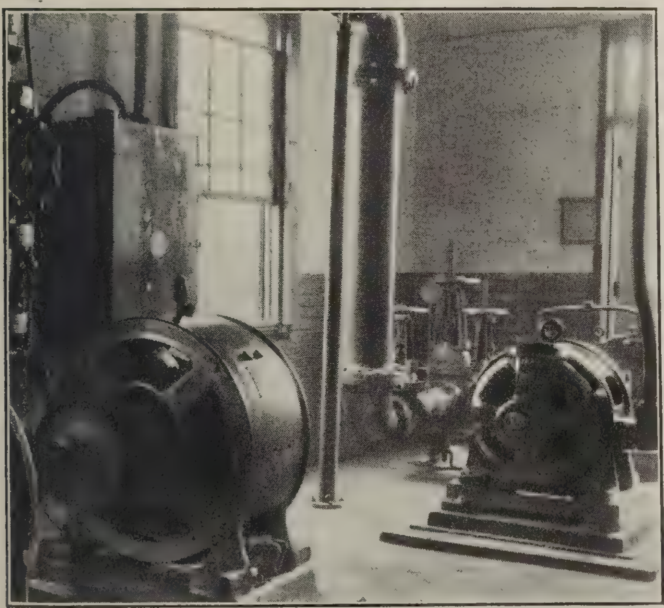
The men work in the following way: Three men are on eight-hour shifts at the power house. One electrician is located in the roundhouse on headlight work, one in the car shop on passenger car lighting, one on armature winding, two repair troubles on new construction and one on lines for outside pumping stations.

In connection with this latter work, it is of interest to note that the Central of Georgia has equipped all water stations where electric power is available for automatic electric operation. If the station is important the old steam equipment is left in, but if it is new, it is made straight electric installation.

Specialists are used at times in dismantling motors, winding coils, shaping coils, winding motors, transformers and various equipment and repairing troubles wherever they may be needed.

New Filter Plant

Among the latest improvements at the Macon shops is the new water filtering plant. Water is pumped from the raw water supply from Ocmulgee River about one mile from the shops. Three 1,200 gallon pumps are located at the river and these are driven by a 40 hp., 2,300-volt motors. These pumps supply a 150,000 gallon reservoir

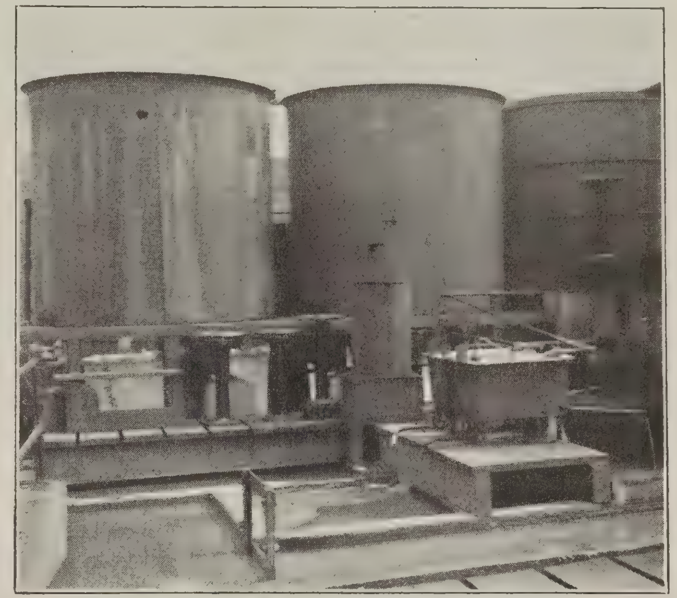


Corner of the Filter House Showing Some of the Electrical Equipment and Pumps

which is the main supply for the entire plant. The water from this reservoir is pumped by a 1,500 g.p.m. float control pump into a metering chamber where the water is metered. It then passes into a mixing chamber where it is treated by the addition of soda and alum. From the mixing chamber the water enters a settling basin of 350,000 gal. capacity. The main settling basin is 90 feet long with a center baffle making the water flow the length of the basin twice and then into a second basin. The water then flows by gravity to either of two rapid sand filters each having a capacity of 540 gallons per minute. The clear water from this filter enters the clear well. Service water is furnished from the clear well by two centrifugal pumps, float controlled, and it is supplied to the roundhouse by either of two lines, or can be pumped into a high fire service tank.

The treatment has two purposes—to clear the water and raise the alkalinity so that it will not be corrosive. The finished water does not form a hard scale.

The settling basin removes 1,570 lb. of solids from the water each day, thus making boiler cleaning and washing a simple task and saving blow-down water. The removal of this amount of suspended matter also prevents its col-

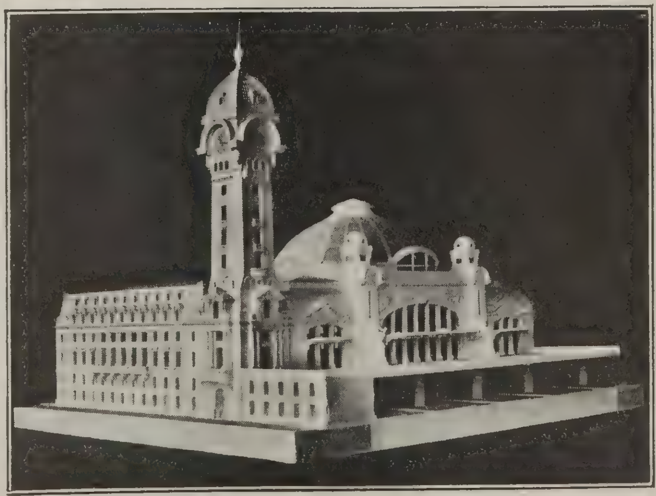


Chemical Control Apparatus Used in Connection With Filter Plant

lection on flues and crown sheets and lessens the tendency to mud burns with the consequent saving in fuel.

No attempt has been made to make the water fit for drinking purposes. It is only good boiler water for engine and shop service.

The entire handling of water and plant equipment is automatic, except the washing of the filters.



Model for New Station at Limoges (Paris-Orleans)

The First of Five 73-ft. Gas-Electric Cars Now Being Built for the New Haven. These cars are equipped with Safety Lighting Equipment.

Lighting Regulation for Gas-Electric Cars*

Equipment on New Types of Rolling Stock Produces Results Which Compare Favorably With Axle Lighted Cars

DEVELOPMENT and success of the gasoline-electric, or oil-electric drive for rail cars and locomotives has introduced still another problem of battery charge. To meet this problem, the Safety Car

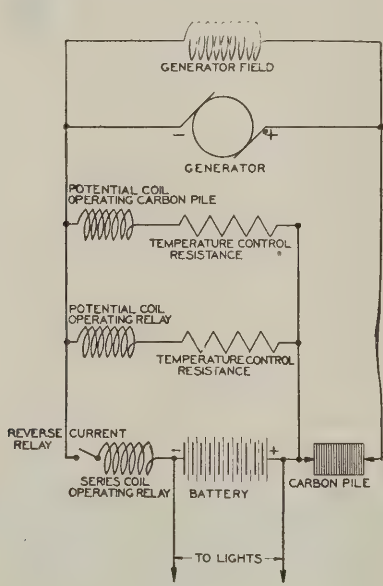


Fig. 1

Heating and Lighting Company has developed apparatus for operation on equipment of the above class.

The gas-electric or oil-electric unit requires a battery for lighting as well as excitation at low engine speeds. Since there is enough electrical energy available in the main power unit, it is natural to utilize some of this source for charging the battery rather than provide a separate generator for this purpose.

The exciter being of relatively low voltage is therefore called upon to charge the battery. Due to the purpose of this generator, its voltage is variable, and consequently some regulation must be provided to charge the battery fully in the least possible time, and yet protect it from dangerous effects of overcharging.

Operation

Fig. 1 shows the schematic wiring diagram of the circuit employed, while Figs. 2 and 3 show the two types of

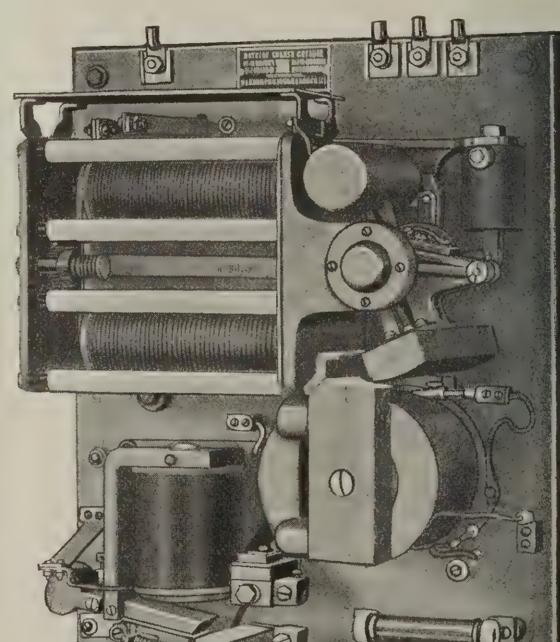


Fig. 2—Type F Battery Charge Control Regulator No. 25937

regulators that may be used in this circuit. Figs. 4 and 5 show the lamp regulators recommended in order to properly protect the lamps.

Whenever the exciter voltage reaches that value for

*Abstract from a bulletin Published by the Safety Car Heating & Lighting Co.

which the main switch is set, is closes and connects the battery to the exciter in series with the carbon pile of the regulator. The potential across the battery is then held to the desired value throughout changes in the voltage of the exciter by the amount of resistance introduced in the circuit by the carbon pile.

The resistance of the carbon pile is governed by pressure exerted on it by levers which are operated by the armature of the voltage magnet. If the voltage tends to rise above that for which the regulator is set to maintain, the armature, through the levers, reduces pressure on the pile causing an increased drop in the pile and thereby holding the voltage to its proper value.

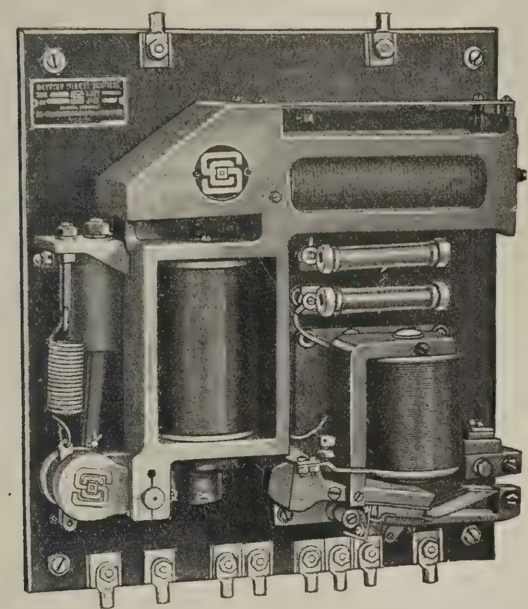


Fig. 3—Type G Battery Charge Control Regulator No. 26466

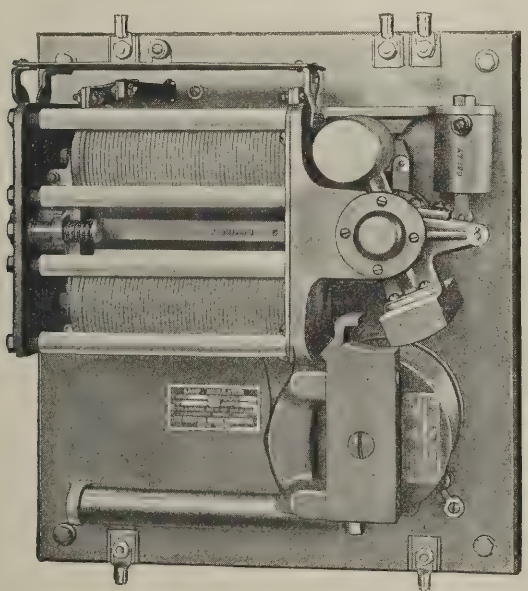


Fig. 4—Type F Lamp Regulator No. 23845

If the voltage across the battery tends to decrease, the opposite action takes place.

The exciter is thus made available for charging the battery as soon as its voltage rises approximately two volts above that of the battery, and yet the battery is not subjected to disastrous overcharging at high exciter voltages.

Voltage at the lamps is controlled in a similar manner, except that the regulator furnished for this service is not equipped with a reverse current relay as none is required. See Fig. 6.

Specifications

The regulators are assembled on ebony asbestos panels provided with bushings for mounting. All co-operating parts are assembled on metal frames which are secured to the panel and can be removed as a unit. All connections are accessible from the front.

All parts of the regulator are mechanically balanced, the regulation being accomplished by springs. This gives constant and close regulation in spite of the jars incident to service and this balancing eliminates heavy liquid dash pots. The regulator uses inverted air dash pots with graphite plungers. These dash pots are constant in action summer and winter regardless of temperature changes and do not become clogged with the dust of service.

All voltage coils are compensated for change in voltage due to heating of the coil winding by a zero heat co-efficient resistance placed in series with the coils.

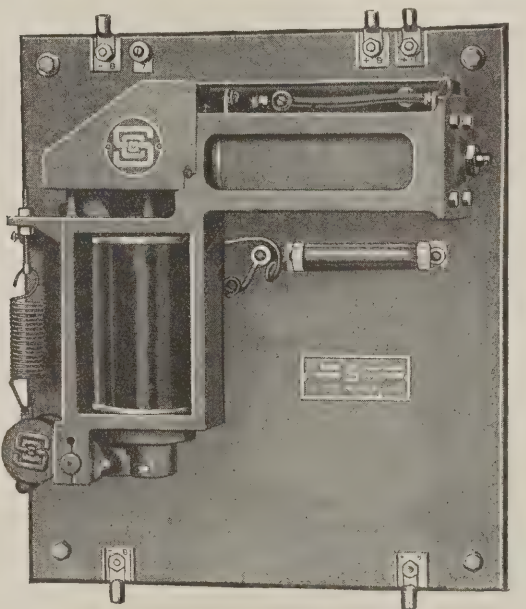


Fig. 5—Type G Lamp Regulator No. 24930

The Type F Regulating Unit

The type F regulator consists of two piles of carbon discs in series with the lamps, the two piles being connected in series or in parallel depending upon the application.

Pressure on these carbons, and therefore their resistance, is governed by the armature of a magnet the winding of which receives the regulated voltage.

A unique design of magnet and levers insures high degree of accuracy and voltage regulation without the use of any auxiliary control.

The carbons are compressed by an adjustable spring, connected to a link, acting through the lever connection. The pull of the spring is opposed by the pull of the electro-magnet which is connected directly across the lamp mains and is so designed that the armature will stay in any position throughout its stroke when the voltage is

right. When the voltage is high the magnet becomes stronger and pulls the armature down against the pull of the spring and reduces pressure upon the carbons, increasing their resistance and bringing the voltage back to normal. If the regulated voltage is low, the magnet becomes weakened, the spring pulls the armature back, and through the lever connection, exerts enough pressure on the carbon piles to decrease their resistance and bring the voltage back to normal.

The Type G Regulating Unit

This regulator consists of a single pile of carbon discs of the same size and thickness as those used in the type F regulator. These carbons are compressed by a movable back plate through the pull of the tension spring acting to compress the carbon discs through the solenoid core and a vertically operating cam attached to the top of the core and bearing against the movable end plate. Friction at all points of contact is avoided by use of ball bearings.

Action of the spring tends to pull the solenoid core in

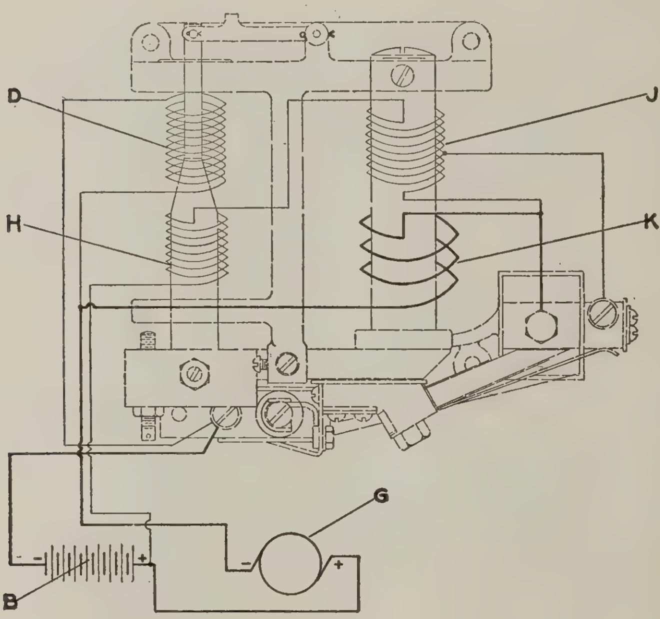


Fig. 6

a downward direction and compress the carbons. Energizing the solenoid tends to pull the core in an upward direction and release the carbons. When the voltage is normal the spring pull balances the solenoid pull. If the voltage goes above normal, the solenoid overbalances the spring pull and releases pressure on the carbon discs bringing the voltage back to normal again, when another balance is obtained. If the voltage drops below normal, the opposite action takes place.

The design is such as to give high pressure for low drop when a minimum resistance is desired, combined with sensitiveness of action to hold the voltage normal under varying conditions of generator voltage.

The Reverse Current Relay

The main switch or reverse current relay furnished with the battery charge control regulators can be one of two types; one being an automatic switch of the closed magnetic circuit type with pivoted armature. This switch is shown in the schematic diagram referred to in the foregoing. It has a shunt lifting coil for lifting the armature, bringing into action a series coil which holds the switch tightly closed and assists in opening the switch when the generator voltage falls below the battery voltage. Carbon contacts are provided to prevent arcing at the main brush.

Fig. 6 shows the schematic wiring of an improved reverse current relay which, instead of operating at a predetermined value, is designed to close whenever generator voltage equals that of the battery. It can also be adjusted to close at a fixed difference between generator and battery voltage.

There are three voltage coils and one series coil. The coil *D* is connected across the contacts of the switch so that voltage impressed across it is the difference between battery voltage and generator voltage, and if the generator is not operating, full battery potential is available. The

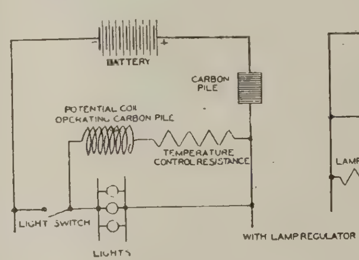


Fig. 7

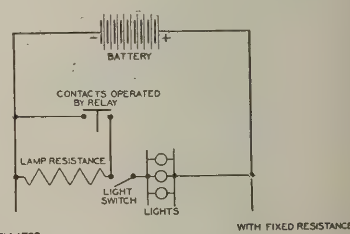


Fig. 8

pull of this coil on the auxiliary plunger locks the switch in an open position. At the same time the current from the battery which energizes this coil also serves to energize the field of the main generator so that it will always build up in the proper direction.

Coils *J* and *H* are in series across the generator so that as the generator builds up, coil *J* tends to close the switch, while coil *H* serves to replace coil *D*, which becomes inoperative as generator voltage approaches that of the battery.

The design of these coils is such that correct balance is obtained at any battery voltage encountered in service. Consequently, when the armature is set with the proper

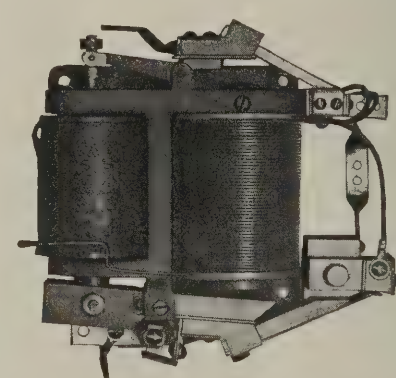


Fig. 9—Type 10R Switch No. 26234

gap, the switch closes when generator voltage equals that of the battery. The series coil *K* serves to lock the switch closed when the generator is charging the battery and also serves to neutralize coil *J* when the battery attempts to discharge to the generator. The tap from coil *J* brought out to the contact on the switch serves to reduce the strength of coil *J* so that a very small discharge from the battery will open the switch. It is thus possible to eliminate carbon contacts formerly used. Due to the fact that operation of this switch depends upon the balancing of the voltage coils *D*, *H* and *J*, the effects of temperature

changes in the coils cancel each other. It is therefore not necessary to place resistances with zero temperature coefficients in series with the coils to obtain the same operation under various changes in temperature.

Fixed Resistance Lamp Regulation

For units with small lamp load, where accuracy of lamp regulation is not desired, life of the bulbs may be increased by the use of a fixed resistance control as shown by the schematic diagram in Fig. 8. With this arrangement, a resistance is automatically inserted in the lamp circuit whenever the battery is connected to the generator by the reverse current relay. The contactor which shorts the resistance in the lamp circuit when the lamps are fed directly from the battery is mounted on top of the reverse current relay.

This modification is only provided when the reverse current relay shown in Fig. 6 is used. This switch complete with contact is shown in Fig. 9.

Chicago & Alton Purchases 8-Wheel Highway Coaches

The Chicago & Alton will soon place in service two eight-wheel highway coaches purchased from the Versare Corporation, Albany, N. Y. These coaches will be operated by the Albion Transportation Company, the bus-operating subsidiary of the railway, on the first of two bus routes (extending from Jacksonville, Ill., to St. Louis, Mo.), which the Alton is placing in service this year.

The eight-wheel, double truck design of the coaches is a new development in bus construction. These coaches are also said to represent the first gasoline-electric equipment for highway operation purchased by a steam road.

One of the 8-Wheeled Coaches

They were developed by the Versare Corporation and the Westinghouse Electric & Manufacturing Co.

Although the coach is 35 ft. 6 in. in over-all length, it can be completely turned around without backing in a street only 40 ft. wide. This is accomplished by means of a patented steering system which permits each wheel to run on a true circle, the wheels of the rear truck following almost identically in line with those of the forward truck. The eight wheels are used in the form of two complete and duplicate trucks which are in reality small chassis in themselves. The trucks turn about a kingpin placed slightly in the rear of the front axle of each truck. The driver controls the front wheels of the forward truck by means of a steering wheel in much the same manner as any ordinary self-propelled vehicle. The steering column is connected through gears and levers to a quadrant to which the tie rods to the front wheels are fastened. The use of this quadrant causes the travel of the tie rods to be such as to keep the truck wheels tangent to their own circle of turning. The two front truck wheels are therefore parallel only when the coach is running on a straight road. The two front wheels of the front truck are turned in the desired direction by the driver and their pull causes the truck to turn in the proper direction. The action of the front truck, therefore, is very similar to the action of the ordinary four-wheeled vehicle.

The turning action of the rear truck is similar to this. Its two front wheels are controlled by an automatic steering device which permits articulated steering. Tie rods to the front wheels of the rear truck are attached to a quadrant mounted flatly in the rear of and at the center of the axle. Control for this quadrant is provided by a telescoping rod attached to a point on the frame about three feet in front of the axle. In operation the rod is turned by the body and actuates the quadrant to which the tie rods are attached.

The seating capacity of the coaches is 33 passengers. Of these, 24 are provided for by standard leather-upholstered cross seats and the remainder by a rotunda seat extending along the sides and around the rear end. Standing space for 37 passengers is provided. Lighting is furnished by open shade fixtures and ventilation is obtained by 12 standard railway type ventilators.

The coach is equipped with a 120 hp. six-cylinder engine connected to a 40-kw. Westinghouse generator by means of a disc-type coupling and the two are mounted as a unit on a sub-frame. The generator with a continuous rating of 40-kw. at 1,200 r.p.m. is a specially designed machine provided with a field winding arranged for supplying a small amount of separate excitation to assure a positive pick up and stable operation under all load conditions.

No series field winding is provided on the generator. A resistance is inserted in the generator field to permit varying of the field strength. During normal operation the field resistance is at a minimum.

This scheme provides a flexible overall reduction between the engine and the wheels of the coach, making the speed of the engine practically independent of that of the coach, and, therefore, permitting the engine to be run at high speed with low coach speed.

Upon the engine are mounted the electric starting motor with Bendix drive; a 600-watt lighting generator working through a voltage and current regulator; a 6-foot air compressor with unloader; the magneto with automatic spark control; a carburetor with hot air control; an electric fuel pump; a reservoir for the Duplex oiling system; dual aero type fans and the conventional water pump.

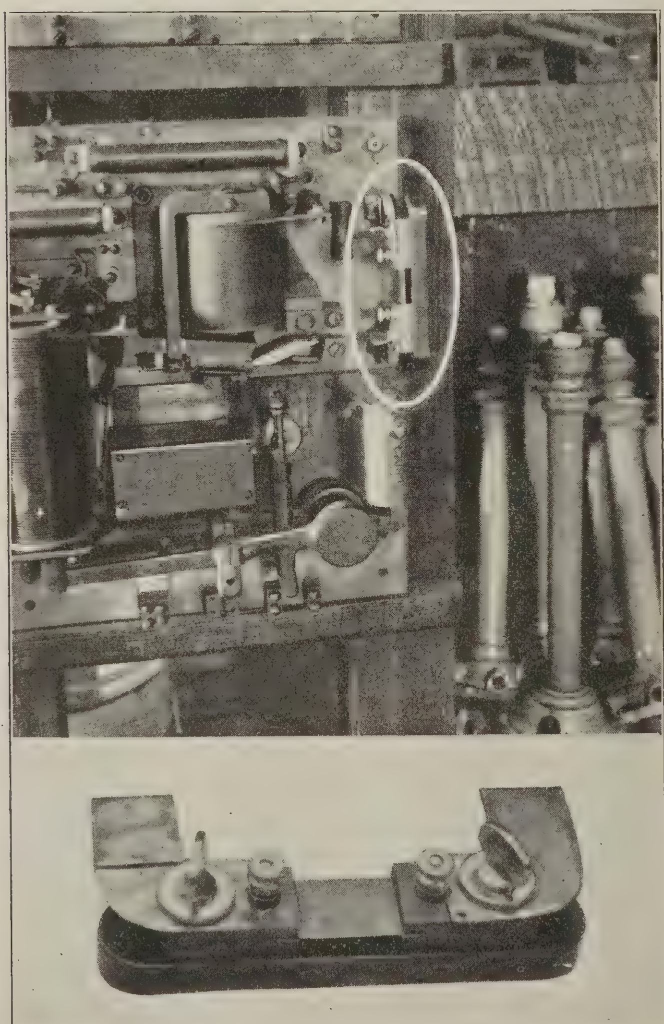
At each end and on the underside of the sub-frame are the insulated shoes which provide a rubber suspension that cushions vibration and insulates against current leakages.

The generator is capable of utilizing the full output of the engine and is able without overheating, to supply full power to the two traction motors. The motors are of the vehicle type and have a nominal rating of 28 hp. at 175 volts. They are so constructed as to protect the commutator against dirt and water.

The main controller and braking controller form the principal parts of the control appartus. The main controller has three operating positions, series and parallel, forward, and parallel reverse. The parallel operating position forward is the first position from the "off" as it is used more frequently than the series.

Attachment for Millivoltmeter Shunt

In order to do away with the necessity for carrying a large ammeter and a heavy pair of leads when taking current readings, a very simple change may be made in the



Upper: Application of Shunt Showing How it Fits Into Clips When Main Fuse is Removed. Lower: Enlarged View of Shunt Showing Shape of Extension Pieces

ammeter shunt. The change consists of making two L-shaped pieces of flat copper and placing them under the binding screws at each end of the shunt mounting. These copper pieces are so fastened that the spacing between them corresponds to the blades of a 100-ampere fuse. In other words, when the fuse is removed, the shunt arrangement may be very quickly applied and current readings taken.

The outstanding advantage of this device is that in place of the heavy ammeter and bulky leads, a very small millivoltmeter calibrated to read in amperes, and a pair of small leads may be used. The whole outfit is such that it can be carried in one's pocket. The device was designed primarily to be used in checking up and setting car lighting equipment on the road, but of course, may be used in the place of any fuse, provided the current flowing comes within the capacity of the instrument. This shunt arrangement was designed by the electrical department of the Florida East Coast.

Repair Stand for Edison Battery Trays

A car repairer's horse with a few embellishments is used to good advantage as a repair stand for Edison battery trays in the Southern Pacific car lighting shops at Houston, Texas. The horse proper is made of 3 in. by 1 in.

The Battery Repair Stand Provides Working Facilities for Two Men

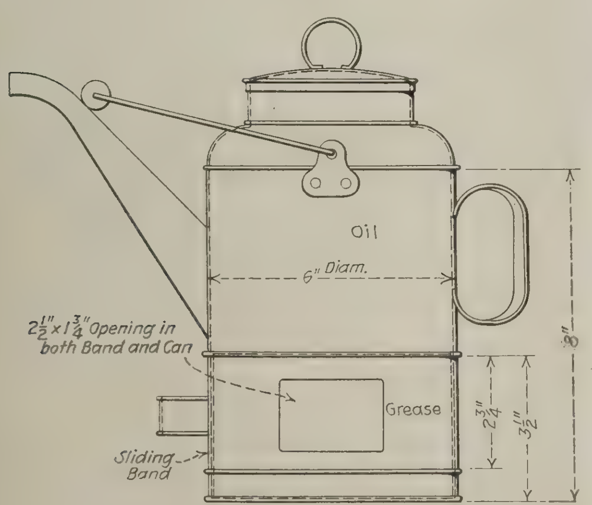
stock and is 37 in. high and 34 in. long over all. The legs of the horse are spread 31 in. apart at the bottom and are fastened together at the top with strap hinges.

There are two cross members on each side of the horse also made of 3 in. by 1 in. material. The top of the lower cross piece is 19 in. above the ground or floor and the top of the upper one is 5 in. below the top of the horse. A shelf or rest is mounted on top of the two lower cross members. This shelf is made of two pieces of ½ in. by 6 in. material 33 in. long and two pieces of 1½ in. by 2 in. material 28 in. long. Mounted between the two upper cross members of the horse is a box 7 in. wide, 6 in. deep and 28 in. long. The box is open at the top and is divided into five compartments. The largest compartment is 7 in. wide and 9 in. long and is used for tray buttons and tools. The other four compartments are smaller and are used respectively for ¾-in. No. 10 screws, 1¼-in. No. 8 screws, 1¼-in. No. 10 screws and 1½-in. No. 10 screws.

When a tray is to be repaired or when the cans are to be taken out of the tray, the tray is placed on the stand as shown in the illustration. In this position it is easy to take out and to drive screws and the assembly work is accordingly made easier as it consists essentially of driving screws.

Combination Oil and Grease Can for Car Lighting Electricians

A combination oil and grease can shown in the illustration has been devised by J. F. Duke, car lighting electrician on the Chesapeake & Ohio, at Clifton Forge, Va. The can is used particularly by car lighting electricians, although it will be found useful by anyone using oil and grease around railroad yards. The band around the can prevents all dust and grit from getting into the grease.



Sketch Showing Construction of Can

The can will hold enough grease and oil for two bearings and five or six suspension beam pin grease cups on body hung machines.

In the case of a car lighting electrician, it acts as a reminder when he goes to a machine with grease due in the bearing, and a dry suspension pin cup. Moreover, he does not have to walk anywhere to get oil and grease as he has it right at hand.

I'd Ruther Be a Vagabond

I'd ruther be a vagabond,
Who folks jist sort o' loved
Than be a hard, high pressure guy
Who allus pushed and shoved;
I may not pile up very much
Of earthly swag and pelf,
But when I leave, I won't deceive
Or even kid myself.

I'd ruther have the folks I know
Believe the things I say
Than grab a lot of useless dough
In some deceitful way;
I've allus figgered Truth will climb
And scale the highest walls,
But the Boob that's full, of lumpy bull
Gets up so high—and falls.

I'd ruther do without a lot
Of things I've allus craved
Than lift them from some simple soul
Who'd allus slaved and saved;
I'd ruther live so I could look
The world straight in the eye
Than have to hide, behind my pride
While certain folks went by.

I'd ruther dumbly plod along
And do my bit each day
Than boldly flash across the sky—
Burn out and fade away;
I've allus felt the world still needs
The steddy faithful hoss
Who pulls his load, without the goad
And works without a boss.

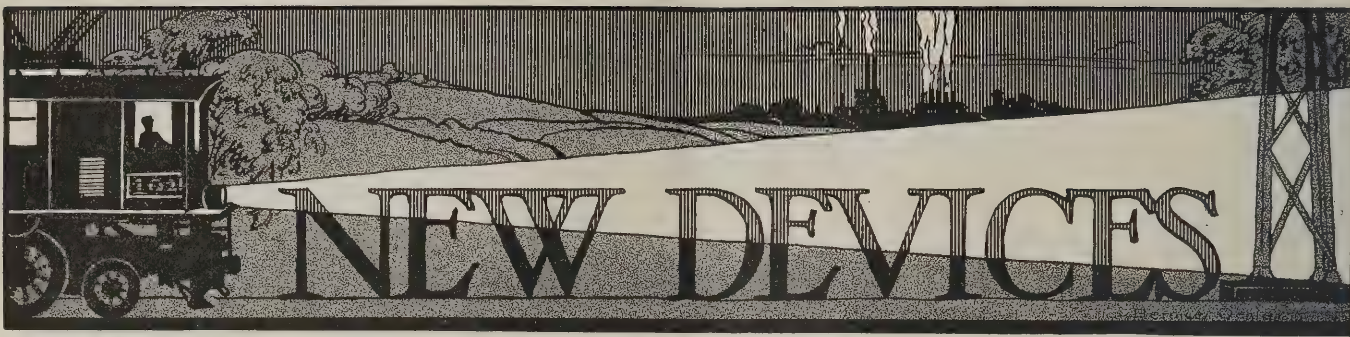
So let me be a vagabond—
Think anything you may;
You couldn't change me anyhow
Because I'm built that way;
And when you feel your world is wrong—
Your pathway full of weeds
Just do your stuff, you'll get enough
For all your worldly needs.

Static

I fain would get wise to what you've got,
This I would know—what is a watt?
Assume I've a watt! Where is it from?
And what relation's a watt to an ohm?
Another question that gives me a cramp,
Is how to tell an ohm from an amp!
And, furthermore, this gives me a jolt!
How does one tell an amp from a volt?

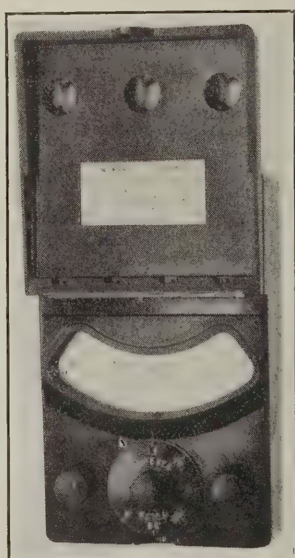
In a dynamo what constitutes a rotor
Why does a generator look so much like a motor ?
Of brush boxes, pole changers and terminal blocks:
I'll have to admit I'm as dumb as an ox.
A. C., D. C. or A. W. G.
All are the same to the likes o' me.
Synchronous converter, or rheostat,
Plus switches and fuses, give me all that!

J. B. Searles.



Portable Volt-Ammeters

The General Electric Company has specially designed its type DS-2 portable volt-ammeters to meet the demands for a compact and accurate direct current instrument that is suitable for general testing purposes. The instrument can be carried in a coat pocket, and has all exposed parts protected by a hinged cover. The case is of bakelite, molded to resemble leather.



DS-2 Volt-Ammeter

Six scales are incorporated in each of the meters, three for voltages and three for current. One of each reads direct, and the other in multiples of 10 or 2. The scale length is about three inches, normally marked in 75 divisions. The change from scale to scale and from voltmeter to ammeter is made by a rotating switch between the binding posts.

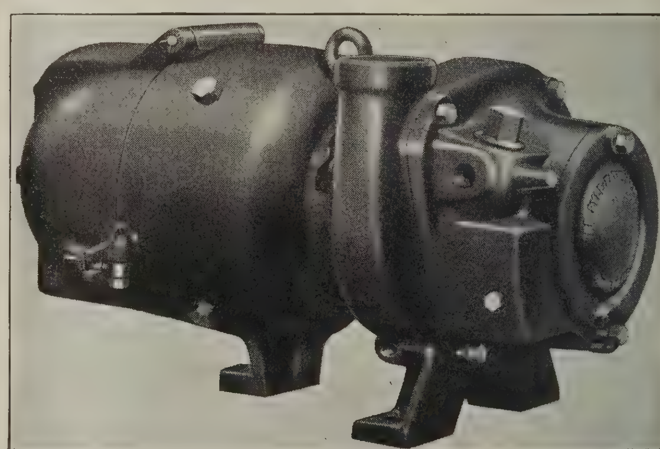
Voltages up to 150 and currents up to 30 amperes can be measured.

Turbo-Generator Designed for Train Control Application

The requirements of modern train control have created a number of new conditions to be met by turbo-generator design. For the combined service of locomotive headlighting and power supply to the train control apparatus new standards of performance are required. In the operation of train control systems, either of the continuous or intermittent types, the important feature of a smooth wave and unvarying direct current supply for the filament, dynamotor and inductor circuits should receive primary consideration. Alternating current in these circuits may introduce a potential failure of the train control. The existence of an a.c. supply in the amplifier circuit may introduce an overload or parasitic loading of the vacuum tubes with a probable failure of the train control. A two or four-pole generator with a ring wound or lap wound armature contributes to the undesirable possibilities due to the inherent characteristics of these types.

With the belief that no adaptation of a standard headlighting generator would be satisfactory for train control service, the Pyle-National Company designed a special unit for this service. The Type E-3 turbo-generator was the first machine on the market which was built specifically to meet train control requirements. It was designed to give a smooth, flat voltage wave form, and to retain its special characteristics throughout its entire service life. These machines, of which there is a number now in operation, have given satisfactory service.

Based upon operating experience with the Type E-3 unit, and in response to a definite demand for a smaller machine, the Pyle-National Company has designed the new Type MO-6 turbo-generator for combined headlighting and train control service. This machine weighs 185 lbs., and because of its size, the new design of the unit is said to be easier to handle and to maintain than



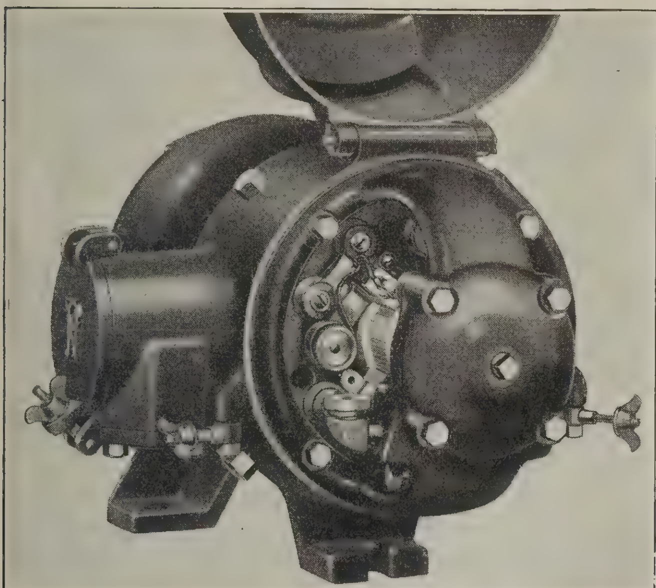
Side View of Type MO-6 Turbo-Generator Designed for Train Control Application

other machines. The Type MO-6 retains all the distinctive features of the Type E-3 turbo-generator in a slightly smaller machine. It provides ample capacity for locomotive lighting and, in addition, ample capacity for all the requirements of either the continuous or intermittent types of train control.

Simplicity in design has been given particular attention in the production of the Type MO-6 unit. As example, the ball-bearings in each end are duplicates, thus requiring but one type of repair stock, and the entire bearing mounting has been made unusually accessible. The brush ring is a bakelite with lugs for locating its position in the yoke. The brushes and rigging can be removed as a unit, and replaced quickly and easily without any possibility of altering the brush position. The new machine has few parts which simplifies maintenance

operations and reduces the number of parts required for repair stock. The turbine end of the Type MO-6 is similar to that of the Pyle-National Type M. turbo-generators of larger capacities. The governor is of the same design (mounted as a unit) as that used in the Type-M machines for train lighting service. The water rate of the Type MO-6 turbine is claimed to be very low.

This MO-6 generator is a four-pole machine with an improved type of field coils. The armature is wave form wound and four brushes are provided, although two would suffice. This extra set of brushes is provided to insure



End View of Pyle-National Small Turbo-Generator Unit

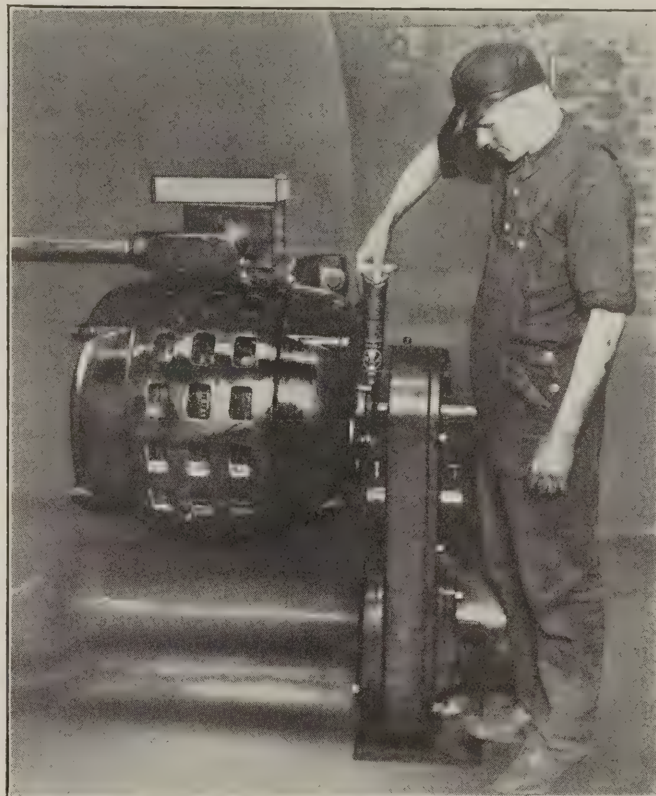
perfect commutation. Either one or two of these brushes can be lifted without causing any change in the operating characteristics of the unit. Since the machine has four poles with a wave form wound armature, and operates at 3,400 r.p.m., alternating current is said to be definitely excluded.

Grease-Tube Method of Motor Lubrication

Another improvement that further simplifies ball bearing motor lubrication has been instigated by Fairbanks, Morse & Co., Chicago. It consists of furnishing the proper greases in collapsible tubes, each containing just enough grease for a motor's annual requirements. After flushing out the old grease with kerosene the new FMCO grease is squeezed from the grease tube directly into the bearing. The directions show just how much to put into each bearing for the best results. Four sizes of tubes are available for corresponding sizes of bearings.

There are many advantages in this tube method of greasing. The kind of grease best adapted for ball-bearing is used. It is of the proper adhesiveness to cling to the balls; it maintains its consistency through all normal temperatures without being too stiff when starting in the cold, or melting and flowing out of the bearing when running at full load. It is free from gritty or corrosive constituents. No dirt or other deleterious matter is introduced into the bearing. The likelihood of using a stick or other random object of questionable cleanliness of taking grease from an open can to the bearing is entirely eliminated. The cap of the housing is not removed, only the plug. No grease is wasted or smeared outside of the housing and no wiping is needed. Just the right amount of grease required for the most perfect lubrication is used in each bearing.

The manufacturer states that it must not be assumed, because the grease is furnished in tubes, that this is an



Lubricating a Motor by the Grease Tube Method

expensive method and that the slight cost of the tubes is usually offset by the elimination of waste in the use of grease. This refined method of greasing thus secures both economy and convenience in lubrication and maintains the efficiency of the bearing at a maximum.

Shipping and Installing Crate for Glass Jar Storage Batteries

The group installation of glass jar storage battery cells in connection with the now widely used A. C. floating battery system of railway signal power supply is facilitated by the use of installation crates or trays. Such crates present the advantage that the several cells comprising the battery installation are handled as a single tray unit. The crate prevents the possible shifting or moving of the cells as the result of vibration caused by passing trains, while at the same time the slatted construction of the tray sides leaves the cells exposed for inspection.

Heretofore, installation crates have either been purchased from the storage battery manufacturers or built locally. In either case, their cost, while not great, has nevertheless been an appreciable item in the complete cost

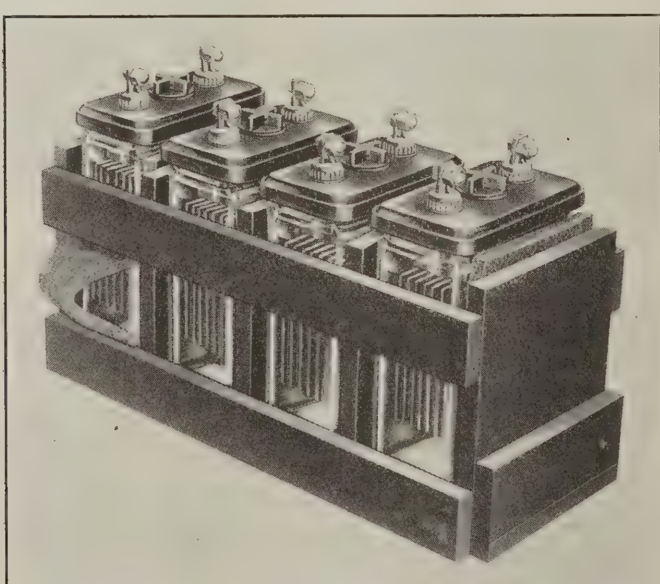
of the battery installation. In view of the very large number of battery installations now being made, it is interesting to note the development by The Electric Storage Battery Company of a novel double purpose crate for sealed glass jar cells which serves both as a shipping crate and an installation crate.

Referring to the illustration, the crate is shown as

Battery in Complete Combination Crate Ready for Shipping

packed for shipment. By removing a few wood screws the unpainted parts are readily removed leaving a practical and serviceable installation crate with the cells in place in its compartments.

For shipping purposes, the individual cells are nested on strips of heavy felt. In making the installation these



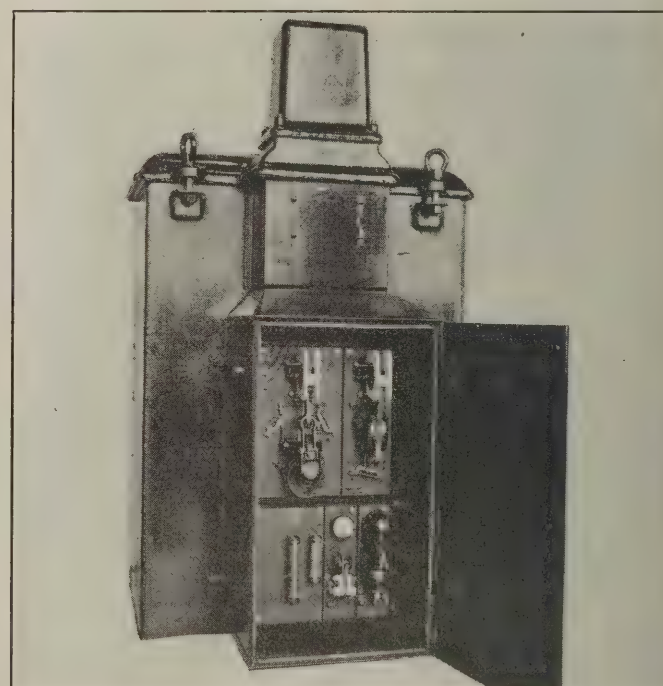
Battery As Illustrated with Shipping Parts of Crate Removed

may be left in place or may be readily pulled out to expose the cell for operating inspection. A few moments, therefore, suffices to transform the unit as packed for shipment into an installation unit ready for placing in the battery receptacle.

The double purpose crate is adapted for all types and sizes of Exide sealed glass jar cells commonly used in A. C. floating service. Inasmuch as no additional charge will be made for the double purpose crate as compared with ordinary packing a very considerable saving will result to railroads using these crates.

Oil-Immersed Automatic Starter for Synchronous Motors

A completely self-contained, oil-immersed automatic starter for 2,300-volt synchronous motors has been developed by the Electric Controller & Manufacturing Company, Cleveland, Ohio. This is built for across-the-line starting of slow speed motors and for reduced voltage starting of the higher speed motors. The illustration shows a reduced voltage starter. The full voltage equipment for starting slow speed motors is of similar appearance except that the height is reduced. In each case the operator simply pushes a button to start the motor and



An Oil-Immersed, Reduced Voltage Starter for a 2300-Volt Synchronous Motor

as the motor approaches synchronous speed, the field excitation is automatically applied.

The reduced voltage starter consists of a welded boiler-plate tank which contains an automatic double-throw switching mechanism, a power transformer for providing starting voltage, potential transformers for providing 220 volts for the master switch operating current and the current limit transition relay, which connects the motor to full voltage when it has been accelerated to approximately 85 per cent of synchronous speed. On the outside of the tank there is a dustproof steel cabinet which encloses a field switching mechanism, field discharge resister, timing relay and direct current field ammeter. This cabinet may also contain an automatic starter for operating a magnetic clutch. The full voltage starter is of similar construction except that the starting auto-transformers are omitted.

The synchronous motor is a very desirable motor to use in shops where there are many induction motors in service as it can be used to improve power factor. It can be applied to such drives as air compressors and similar loads with the result that it will correct disturbances on the power line, saving considerable money for the power consumer and simplifying problems for the power company.

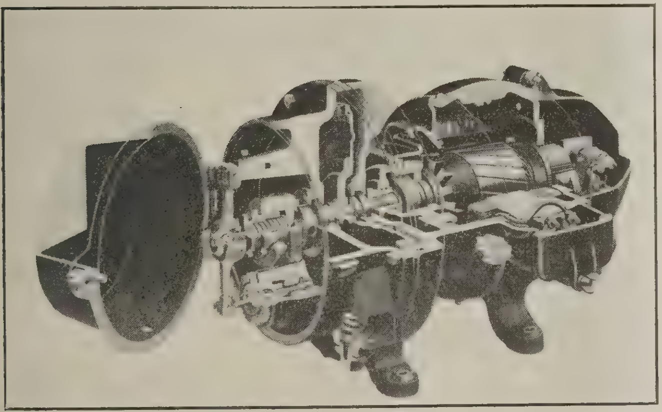
750-Watt Turbo-Generator for Train Control

For train control service the turbo-generator must have characteristics not called for by the generator used only for locomotive lighting. Freedom from detrimental voltage ripple and stray currents and uniform and constant voltage are essential. In the Sunbeam turbo-generator type RE-3G these features are safeguarded by the electrical characteristics of the generator and the governor.

Detrimental voltage ripple and stray currents are eliminated by a wave wound armature with the armature slots at an angle to the pole faces, a commutator having double the usual number of segments and wide brushes. Good commutation is assured by box type spring held brush holders and a ball bearing at the commutator end of the shaft which eliminates commutator wobble.

The constant speed governor is designed to maintain constant voltage throughout the entire range of loads and steam pressure changes.

The Sunbeam type RE-3G train control generator is designed for both continuous and intermittent train control service. It is a two-pole 750-watt capacity 32-volt generator driven by a two-stage radial impulse turbine. To safeguard its performance all parts are enclosed in a



Phantom View of Generator Showing Type of Construction

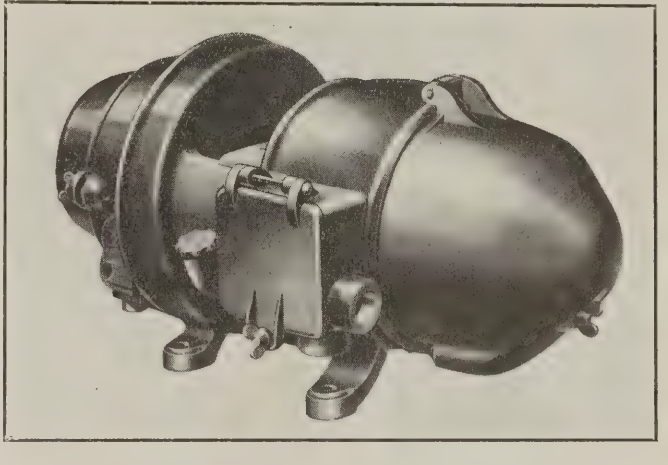
water tight, dust proof case. The terminal box is integral with the main frame and tapped for rigid conduit.

As before stated special attention has been given to produce uniform voltage and freedom from detrimental voltage ripple and stray currents. This freedom from stray current has been so highly developed that the reading of an output meter is zero and the voltage ripple as shown by oscillograph records is negligible.

The Sunbeam governor is rugged and has unusually heavy weights. It is balanced to respond to very small variations in speed and maintains practically constant voltage at all times. Actual service has shown that it will maintain speed and voltage settings over a long period of time.

The Sunbeam governor operates in the atmosphere where it can be effectively lubricated. Lubrication is positive which effectively prevents wear. This maintains the original valve travel setting over long periods and reduces frequency of adjustment.

The steam valve controlled by the governor is of the balanced piston type. It works in a renewable cage in the generator frame. Steam pressure opens it and the governor tends to close it, thus controlling the steam to the turbine. In event of failure of the governor mechanism steam pressure moves the valve to cut off position stop-



Sunbeam 750-Watt, Type RE-3G Generator

ping the flow of steam to the turbine and preventing excessive speed.

All parts of the generator are enclosed in a water and dust tight case, but are also readily accessible for inspection or repairs. Simply raising a hinged cover exposes the commutator end, opening a hinged cover at the turbine end exposes and gives easy access to the governor mechanism.

Adjustment or replacement of a part is a matter of but a very few minutes and all parts are interchangeable, no fitting being required.

Lubrication is simple, the shaft turns on ball bearings and a ball bearing takes the governor thrust. These ball bearings which work in an oil bath are the only parts that need lubrication. The oil wells cannot be overfilled and are designed to insure perfect lubrication without allowing oil overflowing and saturating the windings.

Locomotive Wiring Fittings

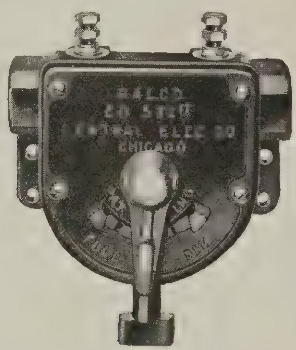
Three new devices including a headlight switch, a switch fitting and a drop cord fitting are now being offered by Central States General Electric Company, Chicago, Ill. These fittings have been designed to meet the exacting demands imposed upon headlight equipment by the introduction of train control.

The Ralco CO552A locomotive headlight switch is totally enclosed, dust proof, waterproof, and compact. This new construction eliminates the possibility of grounds, and the compactness feature is appreciated when wiring is being installed in the present day modern cab, which is crowded for room with all of its modern equip-

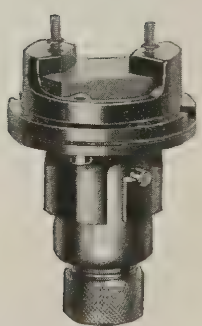
ment. This device is also equipped with a special switch to control the engineer's reading lamp, eliminating the use of a key socket in this fitting.

The Ralco 5092C switch fitting is also totally enclosed, dust proof and waterproof. It was designed to replace toggle and other similar switches in use on locomotives. Its rugged construction with all parts renewable, warrants its use in this heavy duty service.

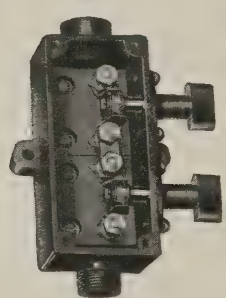
Fittings used where drop cord connections are made to a locomotive wiring system should be so constructed that they can be easily disconnected. The current carrying



Locomotive Headlight Switch



Drop Cord Fitting



Enclosed Switch Fitting

parts should not be depended upon to carry mechanical strain.

The disconnecting feature must be positive and so constructed that it will not fall apart or disconnect circuit when subjected to any amount of vibration and strain.

The above requirements are incorporated in the Ralco drop cord fitting 507U type. As this unit can be applied to any 507-508 or 523 type fitting, shown on pages 143 to 147 inclusive of its catalog 45-C, without disturbing the conduit system; the suffix U has been added to the type number to facilitate ordering.

14-inch Glass Reflector Headlight in Rust Proof Steel Case

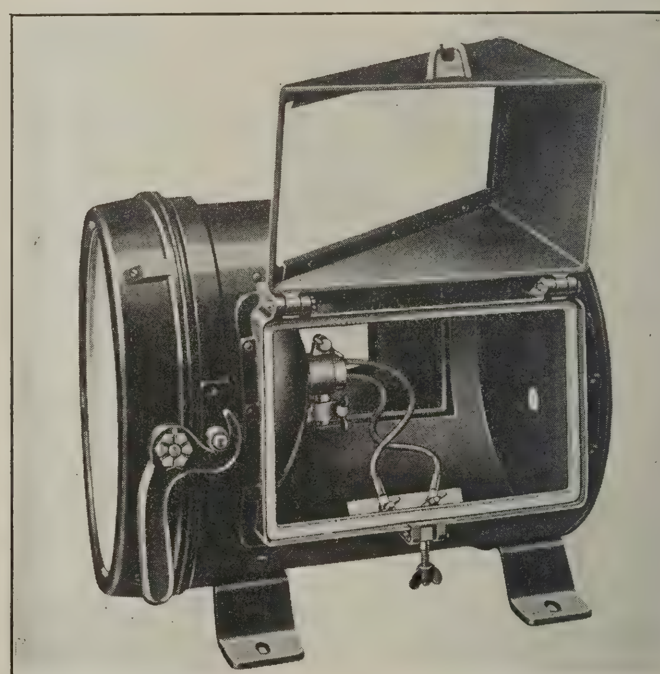
A glass reflector headlight in a rust-proof case is now being made by the Sunbeam Electric Manufacturing, Evansville, Ind., which is designed to meet the three essentials of a locomotive headlight, namely, adequate illumination, long life and minimum maintenance. With a standard 250-watt lamp, the manufacturer states, the headlight produces over 600,000 beam candle power.

The Headlights are made in three types. Type 4414, has the side number plates parallel to the center line of the locomotive. Type 4414-A, has a side hand hole but no number plates. Type 4414-B, has the side number plates on a 30 degree angle. In all other details the headlights of this type, known as the 4400 series, are identical. All types are made with visor if desired.

Rest-proof steel, 16 gage is used for the case and back. Claim is made for the case that it shows no corrosion when exposed, unpainted, to atmospheric conditions in the roundhouse or on the road and that it has 50 per cent greater strength than ordinary steel. Thus in addition to providing protection against atmospheric corrosion it also provides that additional strength to resist rough handling and abuse.

All joints in the headlight case are welded. The back is flanged and welded to the case. The legs are made of 3/8-inch by 2-inch wrought iron.

The reflector is made of amber tinted glass ground to a parabolic curve on front and back. It is 14 inches in



Sunbeam Rust-Proof Headlight, Type 4414-B With Number Door Open Exposing Focusing Device and Terminals

diameter and has a focal length of 3¼ inches. A chemical deposit of pure silver is made on the back of the reflector which in turn is protected by a copper electroplate and several coats of special paint. The reflector is then mounted in a felt lined, rust-proof steel back pressed to the same shape as the reflector. This metal back securely holds the reflector, prevents breakage and protects the silvering against damage while the lamp is being inspected or focused. The reflector retaining ring is also made of rust-proof steel. A clear crystal glass reflector can be furnished if desired.

The front door is a heavy casting. It provides a rigid bearing for the front glass and a tight joint against the case. Between the case and the front door heavy jute packing insures a weather tight seal.

To maintain this seal indefinitely a malleable iron front door latch is used with adjustment to compensate for packing shrinkage. This is accomplished by means of an eccentric latch pin bushing having sufficient adjustment to insure a tight joint at all times.

The front door hinge pins are made of ½-inch brass and secured to the case. This permits lifting the door from the case without removing the pins. Heavy glass is used in the front door with packing between the glass and the door.

The side number frame and door are cast metal. They are applied either parallel to the case or in the Type "B" at a 30 degree angle to the case. This door is hinged at the top and arranged so that the entire extension swings up making the terminals easily accessible. Jute packing between the side door and frame and cork packing between the door and glass insures a weather tight joint. The side number door latch consists of a heavy brass bolt with an iron wing nut.

Universal movement is provided by the focusing device, pattern 10, regularly furnished with this headlight. Lateral and vertical adjustment is easily made and is maintained by wing nuts. All parts are made of heavy brass.

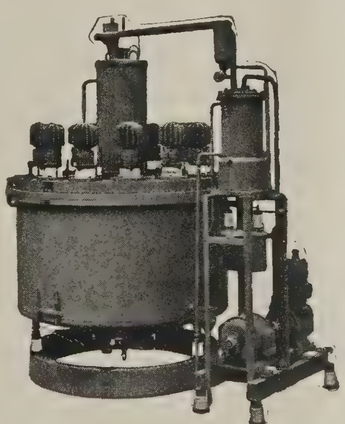
If desired, the Sunbeam focusing device, pattern 14, can be furnished. This device is similar to pattern 10 but adjustment is controlled by knurled screws, and locked by wing nuts.

The number lamp socket is mounted in top of the case and so located as to adequately illuminate the number plates. It is easily accessible through the side door.

For mounting the two terminal screws a plate is fastened under the side door frame. This plate and terminals are easily accessible through the side door.

Mercury-Arc Power Rectifiers

Large mercury-arc power rectifiers are now available for the same class of service in which motor-generator sets or rotary converters are employed The basic principle is identical with the familiar mercury-arc glass enclosed rectifier used in rectifying a.c. at house lighting voltages for charging storage batteries.



Large Type of Mercury-Arc Power Rectifier

These units for current conversion in all capacities and voltages now standard for rotary converters and motor generators are now being offered by the American Brown Boveri Electric Corporation of Camden, N. J. They may be secured with capacities up up to 3000 kw. at 4000 volts d.c. There are now in successful operation, rectifiers of this type having a total capacity of 350,000 kw.

Advantages in both maintenance economy and power efficiency are afforded. A high efficiency curve which maintains its high efficiency even at low load factors characterizes these devices. Absence of rotating parts eliminates the inherent drawbacks of machinery possessing such parts and creates a quick adaptability to sharply varying loads only feasible in the absence of rotational inertia. Rectifiers may be used in parallel with other types of conversion equipment with the advantage of requiring no synchronizing.

Rectifier installations require very little attention and maintenance and in the fifteen years during which the number of such installations has steadily grown, no indication has developed that would point to anything but an indeterminately long life for them.

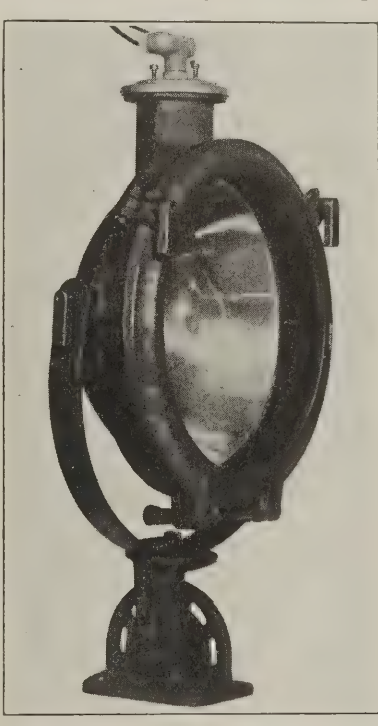
A further favorable point is found in the absence of hum and vibration which has come to stigmatize the sub-station as an undesirable member of residential sections.

The starting and stopping operations may be controlled automatically by any of the following means—by function of the load, by clock, by remote control or by combination of the above conditions. Rectifier substations are fully protected against overloads and short circuits by time-reset relays.

All of the above characteristics tend to especially recommend the rectifier for railway service where the exacting demands of load extremes are thus ably and efficiently met.

Floodlight With Chromium Reflector

A chromium plated reflecting surface, light weight and an air-tight construction are the characteristics of a new cast aluminum floodlight manufactured by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., for railroad yard and roundhouse use.



Unit Has Airtight Cast Aluminum Case and Chromium Plated Reflector

This reflector is claimed to be an important advancement in lighting equipment as the chromium plated surface lengthens the life of the reflector, and is economical because it reduces the necessity of delicate care required with some other types of reflecting surfaces. The chromium plated surface has high reflecting properties and at the same time it is of a tool steel hardness, and is very difficut to scratch with a pin or knife. The reflector will not tarnish or break and is not subject to corrosion from either sulphur or water vapor fumes. With this reflector it is said to be possible to wipe off dust with a gritty waste and still do no damage to the reflector. The highly polished surface presents a very pleasing appearance, and will not lose any of its polish even when scoured, according to the manufacturer.

Another feature of this floodlight is the light weight that is obtained without losing the qualities of rugged and sturdy construction. This floodlight is practically airtight and weatherproof thus preventing all moisture and dirt from entering.

GENERAL NEWS

The Interstate Commerce Commission has postponed until November 1 the effective date of its second train control order, as it affects the Baltimore & Ohio.

The Interstate Commerce Commission has postponed until December 31 the effective date of its second automatic train control order as it affects the Atlantic Coast Line.

The Interstate Commerce Commission has denied a petition filed by the Kansas City Southern for relief from compliance with its order of June 13, 1922, requiring the installation of automatic train control.

The National Carbon Company, Inc., has announced that it has recently taken over the plant, inventory and goodwill of the Corliss Carbon Company of Bradford, Pa. The Corliss goods will continue to be made in the factory at Bradford as heretofore.

The airplane mail and express service of the National Air Transport, Inc., between Chicago and Dallas, Tex., was inaugurated on May 8. Planes leave Chicago early each morning except Sunday, arriving at Dallas approximately 12 hours later, a similar schedule being maintained northbound.

The Chesapeake & Ohio has ordered from the Union Switch & Signal Company, material for the Union intermittent inductive automatic train stop to be installed between Orange, Va., and Clifton Forge, 126 miles, single track. There will be 192 wayside inductors, and 60 locomotives will be equipped. Union color-light automatic visual signals are also being installed on this section.

Norfolk & Western has decided that on its second installation of automatic train stops—Roanoke, Va., to Shenandoah, 132 miles, it will have continuous speed control instead of the "train stop," as heretofore announced, and has directed the Union Switch & Signal Company to make the necessary changes. The introduction of automatic train control on this section involves the placing of apparatus on 50 locomotives.

The Chicago & Eastern Illinois has placed an order with the Miller Train Control Corporation for complete engine equipments for 37 additional engines which run over the territory between Danville, Ill., and Clinton, Ind. This section is the road's second division under the Interstate Commerce Commission's train control order. This installation is of the Miller ramp type system, the same which is in use on the Chicago division.

James J. Moore, a helper on an electric locomotive of the Long Island Railroad who turned a switch under a passenger train at Long Island City, N. Y., on July 30, 1924, was sentenced in the Queens County Court on May 5, to 60 days' imprisonment in the workhouse. One passenger was killed in the derailment that resulted from the turning of the switch under the train. Moore, and also the signalman in the tower, who had unlocked the switch, were held in bail of $25,000 each. The signalman is still awaiting trial.

For railroad men attending the convention of the mechanical division of the American Railway Association at Atlantic City, N. J., June 9 to 16, arrangements have been made for the issuance of trip passes good from June 1 to June 30 inclusive, application to be made by each individual to the pass bureau of those roads with which his own road normally exchanges requests for free transportation. This arrangement is intended to supplant the former practice under which the Pennsylvania, the Reading and the Central of New Jersey issued short term passes good over the entire system.

Electrification Progress in Italy

The newly electrified railway between Sestri Levante, Italy, and Spezia has been opened. Its length is 27 miles. The line from Modane, on the French frontier, to Sestri Levante, a distance of 225 miles, is now completely electrified. Within a few months electric operation will be extended to Leghorn by the conversion of another section 58 miles long. At present the total length of electrified line in Italy is 552 miles.

B. & O. May Operate Buses in New York

The Baltimore & Ohio, it is reported, will operate buses between the midtown section of New York and the Jersey City terminal of the Central of New Jersey which will be the road's New York terminus after it abandons the use of the Pennsylvania station on September 1. This plan,

together with other changes which will be made in connection with the new terminal arrangements, the company characterizes as embryonic.

New York State Grade Crossings

The appropriation bills for the elimination of highway grade crossings passed recently by the legislature of New York, were signed by the governor on May 6; for crossings within the limits of New York City, $50,000,000, and for those in other parts of the state, $20,000,000.

New York Electrification Law Relaxed

The governor of New York on May 18 approved the law passed by the recent legislature authorizing the Public Service Commission, after public hearing, to extend the time within which railroads must cease the operation of steam locomotives in New York City. This law becomes a part of Section 53a of the Public Service Commission law, and allows an extension of not more than five years from January 1, 1926. In compliance with the law the use of electric or oil burning locomotives has already been introduced in New York City to a considerable extent, but the New York Central, especially on its heavy freight line from Spuyten Duyvil, southward to Sixtieth street, has not been able to complete electrification, the elimination of numerous grade crossings being involved in the problem and some time since secured a temporary injunction in the Federal Court forbidding enforcement of the penalties prescribed by the statute, which otherwise could have been imposed on January 1.

Westinghouse Electric & Manufacturing Company

The annual report of the Westinghouse Electric & Manufacturing Company and its proprietary companies for the fiscal year ended March 31, 1926, shows net income available for dividends of $14,122,001 as compared with $15,324,364 in 1925. The income statement follows:

	Year ended March 31	
Gross earnings	1926	1925
Sales billed	$166,006,800	$157,880,292
Cost of sales	151,711,939	144,242,065
Net manufacturing profit	14,294,862	13,638,227
Other income	2,295,363	4,203,179
Gross income from all sources	16,590,225	17,841,406
Interest on bonds	2,468,224	2,517,042
Net income available for dividends and other purposes	$14,122,001	$15,324,364

N. Y. C. Train Control Case

The New York Central has been given a clean bill of health by the Interstate Commerce Commission on the complaint filed by the Sprague Safety Control & Signal Corporation, which the commission has dismissed as having no basis under the provision of its train control orders or other provisions of the law cited. The report by Division 1 recently holds that section 3 of the interstate commerce act does not apply to the making of contracts for the purchase of equipment; that the matter of train control devices is controlled by section 26 and not by the car service provisions of section 1; that the complaint that specifications are being violated by failure to include speed control and in the employment of a forestalling device in the General Railway Signal Company device being installed have no basis. Objections to general device made by Sprague were found not to have been demonstrated on the record and provisions of the Clayton law were found not to have been violated.

American Electric Railway Association to Hold Convention in Cleveland

The annual convention of the American Electric Railway Association will be held in Cleveland, October 4 to 8 inclusive. This is a change from the usual procedure, as the place of meeting has heretofore been in Atlantic City. The change will affect exhibitors in that they will have to seek new space for their exhibits. The exhibit committee of the association sent out on June 1 diagrams showing the booth layout together with application blanks for space.

Personals

A. E. Pratt has been appointed to take charge of the railway sales of Duco and other finishing materials of E. I. DuPont de Nemours & Co., with headquarters at Parlin, N. J. Mr. Pratt was born at West Scarborough, Me., on December 11, 1887, and was educated at Mount Union College and Western Reserve University. After leaving college he spent two years in the maintenance of way department and signal construction on the western lines of the Erie. In October, 1909, he was appointed supervisor of signals of the Buffalo Creek, at Buffalo, N. Y. In January, 1913, he returned to the Erie and served as general signal foreman of construction while automatic signals were being installed on four divisions. In November, 1916, he was appointed signal supervisor of the Buffalo division of the Erie and in April, 1917, was transferred to the Kent division, with headquarters at Marion, Ohio. On March 1, 1918, he resigned to go as sales engineer in the railroad department of the National Carbon Company. Early in 1922 Mr. Pratt was promoted to assistant manager and in January, 1923, was appointed manager of railway sales of the National Carbon Company, Inc., and the Prest-O-Lite Company, Inc., which position he held at the time of his recent appointment.


A. E. Pratt

A. J. Eaves has been appointed as public address and carrier current sales manager for the Graybar Electric Company. Mr. Eaves brings to his new position benefit of over 20 years' experience in telegraph and telephone industries. He was born at Bamberg, S. C., and attended the College of Charleston. Upon the completion of his studies, he entered the employ of the Postal Telegraph and Cable Company, where he remained for ten years.

In 1917, Mr. Eaves entered the employ of the Western Electric Company in New York, where he was connected with the engineering department until the spring of 1925, when he was transferred to the supply department as carrier current sales engineer. He has remained in this position until his present appointment.

Redmond F. Kernan has resigned as an officer and director of the Regan Safety Devices Company, Inc., New York, and Joseph Beaumont, vice-president and sales manager, has been elected director to fill the unexpired term.

W. H. Haile has been appointed manager of the railway sales division of the National Carbon Company, Incorporated, and Prest-O-Lite Company, Incorporated, with headquarters at Cleveland, Ohio. Mr. Haile was born at Galena, Illinois, March 8, 1892, and was educated in the Evanston, Illinois, public schools, high school and the University of Illinois. After several years in mercantile lines and after Army service during the war, he entered the employ of the Union Carbide and Carbon Corporation, the holding company of the National Carbon and Prest-O-Lite Companies, as salesman for the Union Carbide Sales Company, Chicago. A year ago, after holding the position of district sales manager of that company, he was appointed district manager of the Pittsburgh office of the National Carbon Company. He goes from that position to take charge of the railway sales division of that company and the Prest-O-Lite Company.


W. H. Haile

Trade Publications

Allen Bradley Company, Milwaukee, Wis., has recently issued a large number of new bulletins and price sheets to be added to the Allen-Bradley catalogue to bring it up to date.

General Electric Company, Schenectady, N. Y., has recently issued a single page folder describing and illustrating type MF 2 synchronous timer used for accurate time indications of the operation of relays and other devices.

Flexible Fixture Hangers is the title of two illustrated folders recently issued by the Crouse-Hinds Company, Syracuse, N. Y. A number of methods are shown for supporting these fixtures from various types of Condulets manufactured by the company.

Pennsylvania Pump & Compressor Company, Easton, Pa., has recently issued two illustrated bulletins No. 127 and 207, respectively. The former describes direct connected, synchronous motor, air compressors, and the latter is devoted to a multi-stage, centrifugal pump of the single suction opposed impeller type.

A twenty-four page publication has just been issued by the Westinghouse Electric and Manufacturing Company, describing static condensers for power factor correction. One part is devoted to a discussion of power factor, its correction and the selection of corrective equipment; another part describes LD static condensers; the third part is devoted to low-voltage static condensers, describing the construction assembly and application.

The installation, operation and maintenance of switchboards is covered in a new 120-page booklet, paper bound, issued by the General Electric Company. This booklet, bearing the number 87000-E, is illustrated with photographs, diagrams, tables, formulas, etc. It contains much varied information of value to those engaged in the construction, installation and maintenance or operation of switchboards.

Detroit Underfeed Stokers of the single retort type are described in a new 32-page bulletin just issued by the Detroit Stoker Co., Detroit, Mich. Among other items of outstanding interest to combustion engineers, the bulletin contains a number of fuel bed cross sections showing conditions of the fire with respect to air distribution and movement toward the dumps. One section of the book is devoted to the application of the stoker to both low and high set boilers. Another section shows how twin settings serve very large boilers. Copies of this bulletin, which is No. 1018, are available upon application to the company.

Electrical Machinery Catechism.—A publication of this name issued by Fairbanks-Morse & Co., Chicago, presents, in a simple and understandable manner, the fundamental principles of electricity, magnetism and electrical measurements and the important theoretical and practical features of the more common types of a.c. and d.c. motors, generators and control equipment. The material is arranged in question and answer form and is intended primarily for those who are not familiar with electrical terminology. The text matter is illustrated by many drawings and circuits as well as by a number of examples of Fairbanks-Morse machinery. While in some cases the details of Fairbanks-Morse machines are discussed, more complete descriptions are available in other bulletins published by this company.

"The Story of Steel Taped Parkway Cable," is the title of an attractive bulletin of 24 pages recently published by the Okonite Company, and Okonite-Callender Cable Company, Inc., of Passaic and Paterson, New Jersey. Steel taped cable, sometimes called parkway cable, in its most common form, is, in reality, the nearest approach possible to a lead covered cable drawn into a conduit, according to the bulletin which illustrates the construction of parkway cable in detail. Among the many applications of steel taped cable listed in the bulletin are: Ornamental street lighting; police and fire alarm systems, and railway signal and lighting circuits. In connection with its railway application, a few suggestions of the many ways in which parkway cables can be employed economically as a substitute for conduit and lead covered cables, are contained in the bulletin. A specification for rubber insulated steel taped cable is given, together with tables of a few sizes of conductors, suitably insulated for voltages up to 7,000 volts, and the manufacturer states quotations can be given on any size or number of conductors and signal installations not shown. The Okonite Company will gladly supply copies of this booklet to readers upon request.

Railway Electrical Engineer

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June Convention

The semi-annual convention of the Association of Railway Electrical Engineers which was held in Atlantic City on June 14, was marked by the absence of two of the association's most important members. The president, E. Wannamaker, although in Atlantic City was unable to leave his room at the hotel on account of painful eye trouble and the secretary, Joseph A. Andreucetti, was prevented by illness from leaving his home.

Owing to the fact that there were only five progress reports to be presented, the meeting was somewhat shorter than usual and there was comparatively little discussion in connection with the reports.

There is every reason to believe, however, that if Mr. Wannamaker or Mr. Andreucetti had been present, a number of matters would have been discussed aside from the purely technical phases of the committee reports, and it is well known that more progressive and constructive work is being accomplished at the present time than has been for some years past. In a very short time the manual of the association will be issued which will contain much valuable data. At the annual convention in October, there is little doubt but that a number of excellent reports will be presented that will be of real use to the railway electrical engineers and that the progress shown in the completion of work during the year will be most gratifying.

The Gospel of Education

Every electrical man knows that the use of electrical energy and electrical equipment represents a saving which amounts to thousands of dollars. Unfortunately everyone else is not so well informed and there is no doubt but that it is for this reason that the advocates of electric current and appliances are obliged to fight continually for the extension of these facilities.

The railroads seem to be much slower than the industries in grasping the importance of electrical equipment and it is often against the most strenuous opposition that certain electrical devices are installed. Of course this condition will not persist indefinitely, as the advantages of electric power are far too great to remain unrecognized. In the meantime, however, economic losses are steadily piling up and for this reason it is of utmost importance to speed the day when the electrification of railroad shops and other facilities has become accepted as common practice.

The principal factor which will bring about this desirable condition is education—the education of those who should know that electrical equipment saves money but who are still asleep to the fact.

The man who is thoroughly familiar with this fact is the electrical engineer and he is the man who must by force of circumstances occupy the position of instructor, and it may well be remembered that no more interesting text pages can be found than those which point out in clear and unmistakable figures the contrast between the old expensive methods of doing things and the cheaper and better ways by means of electric power. It is the duty of the electrical engineer to preach the gospel of electric extension at every opportunity and to make it a point to collect specific data on installations where money has actually been saved in order to present the strongest case in an opportune moment.

The era of widespread electrified shops and facilities on railroads is not far off and those who make a determined effort to bring it nearer will not only perform an invaluable service to the road which employs them but will incidentally create a stronger and more enviable position for themselves.

Motor Generator Locomotives

There is much speculating being done at the present time regarding the future of the motor-generator type electric locomotive. There are two of these locomotives in use on the Detroit, Toledo & Ironton, the Great Northern will use two of them, and there are seven in course of construction for the New Haven.

The principal advantages of this type of locomotive lie in the facts that power is taken from a high voltage a. c. trolley, thus reducing the amount of copper required in the distribution system to a minimun, and low voltage d. c. motors are used which are highly dependable motors having ideal characteristics for most operating requirements. The principal disadvantage lies in the fact that a large rotating unit must be carried on the locomotive and this unit must be large enough to supply all the traction motors with maximum load current. When substations are located along the right of way, one locomotive may draw power from more than one substation and the total substation capacity does not have to equal the total locomotive capacity.

While the motor-generator constitutes a large portion of the weight of the locomotive, it eliminates a large portion of the control apparatus necessary. Current to the motors is controlled by varying the field of the generator, and the generator field control apparatus is very simple, small and light in weight. Furthermore it allows for an unlimited number of steps of motor control and each

step is a running position. There are no appreciable rheostat losses.

Some fear has been expressed regarding the effect the gyroscopic action of the motor generator may have. This effect has been calculated for the locomotives being built for the New Haven and it was found that when the locomotive is rounding a 10 degree curve at 25 miles an hour the gyroscopic effect of the motor-generator armature will cause a downward force of one ton on one bearing and an equal upward force on the other.

"Why not use mercury arc rectifiers in place of a motor-generator set" is a question which is often asked. This may some time be done, but unfortunately the secondary voltage of a rectifier is practically constant and the use of a rectifier would necessitate the same kind of control apparatus that is used on a straight direct current locomotive. A cooling system would also have to be provided for the rectifier.

The purpose of the motor-generator design of locomotive is to combine the two principal advantages of a. c. and d. c. electrification. It is hoped that maintenance costs will be very low and that operating characteristics will be particularly desirable. First cost of such locomotives is necessarily high at a time when the trend should be downward if electric traction is going to be used in the many places it is desirable. Temporarily at least it adds one more type of locomotive to what seems already unnecessary variety and it is hoped that with these locomotives available for study, that the railroads will be able to select locomotives and electrification systems which will permit some interchange of motive power when that is necessary and which will allow the manufacturers to make electric locomotives which are not burdened with a high development charge.

Future Railroad Power Supply

At the recent meeting of the Railway Electrical Engineers in Atlantic City, a remark was made on the convention floor that unless steps were soon taken to organize the steam power plants of the railroads on a much more efficient basis than that upon which the majority of them are operated today, the time was not far distant when such plants would pass into oblivion and in their place would be substituted purchased electrical power.

It might not be far amiss to go a step further than this and say that whether the steam power plants of the railroads are made more efficient or not, the chances of such plants continuing to exist are decreasing each year, except where it is necessary for them to supply steam for heating purposes.

In the first place, there are only a very few of the railroads that are able to locate their power plants where they have any opportunity for efficient operation and in the second place, the generation of power has become a highly specialized business so that the huge central stations are in a position to develop electrical energy at a cost which cannot be approached by the great majority of railroad power plants. There is little that can be added to the central station equipment to cut down the cost per kilowatt hour, and the result is, as would be expected, that the utmost is derived from every pound of fuel consumed. Aside from the inability of the railroad power plant to cope with the central station in the development of cheap power, there is no good reason why it should attempt to do so. The business of a railroad is transportation and there is an ever-increasing demand for better transportation. Would it not be better for all concerned to eliminate the power problem from the already too long list of railroad activities and release the investment in such plants for more useful work in expediting the movement of traffic.

That railroad power plants, except where required for heating, will eventually pass out of existence is almost a certainty, but in their passing there is nothing to be regretted and in their place will come an inexhaustible supply of electrical energy which will serve to meet the requirements of railroad operation in countless ways which are practically impossible with the smaller isolated power plants of today.

The Electrical Man's Opportunity

The character of work done in railroad service has undergone many radical changes in a comparatively few years. Practically all locomotives are now electrically lighted and electric light is usually the only light considered when new passenger cars are purchased. Individual motor drive or the use of several motors on one machine has made many new types of machine tools possible with the resulting saving of labor and speeding up of operations. Automatic operation of motor driven pumps has displaced many wasteful and expensive steam pumping stations. Good lighting has greatly improved shop and yard working conditions and has prevented many accidents. Electric traction has met the maximum of motive power requirements. Welding has upset many long established and expensive repair methods. Electric trucks are finding much favor. Electric rivet heating is becoming common. Train control will probably be used generally. Electric refrigeration is being experimented with for refrigerator and dining cars.

Practically all of the devices and methods listed above and many others are made possible by the use of electrical energy. It can also be said, that this type of equipment has not been used to the extent it should be or to the extent that it will be. Probably the principal reason that such equipment is not used to the extent it should be is that it is extremely difficult to properly co-ordinate the electrical work done by the various railroad departments.

A few roads have electrical engineers who are responsible for all electrical work, but in many cases the electrical work is done independently in the different departments with corresponding lack of co-ordination. On one road the sole duty of one man is to keep informed concerning the electrical work done by the different departments and to advise all those concerned what equipment should be purchased and thus avoid the accumulation of a motley assortment of different kinds which restricts interchangeability and complicates storekeeping and the making of repairs.

Most important of all the electrical man must be equal to his opportunities; he should be able to answer each new question that is put to him and to make voluntary suggestions for improvements even though it may entail additional work. If he adopts the orthodox policy of just trying to keep out of trouble, he will be relegated to routine work and his department will also suffer. On the other hand, electrical applications to steam railroad service are now being made so rapidly that there are splendid opportunities for all who really want a good job.

A Section of the New Power and Signal Control Line in Which 25,000-Volt Glass Insulators Are Used

New York Central Installs Division Power Line*

Transmission Voltage of 4600 to Supply Ample Power for Signals, Train Control and Other Roadway Facilities

THE erection of a division power line on the New York Central for the purpose of furnishing electrical energy to pumping stations, train control, signal system and other electrical equipment is probably the forerunner of similar lines on this and other railroads. Moreover, it will probably prove true on most roads that power and other devices might be installed that would reduce labor costs to an extent warranting the required expenditure.

As showing what may be done along this line a description of the power line being erected on the 145-mile Mohawk division should be of interest. Approximately 25 miles of 4600-volt line receiving power from two locations has been placed in service. In addition 27 miles of signal line has been erected with space for a 4600-volt line on top. Twenty-eight additional miles are being built this year and remaining sections will be erected in steps as authorized. Plans and engineering work for the entire division have been completed and parts of the installation not completed will be installed in the same manner as herein described.

Survey Made to Determine Most Economical Construction

Owing to the many engineering problems to be solved a careful study had to be made of the several different constructions that might be used in order that the best and most economical might be decided upon. The existing Western Union poles carrying signal wires were in need of renewal and as an increased supply of power for the train control system being installed was required beyond the capacity of the existing signal supply line it was necessary that a new pole line be constructed to carry the signal wires and a high-tension transmission line that would furnish an ample supply o. power.

* Abstract from an article by R. B. Elsworth, Assistant Signal Engineer, New York Central R.R., published in *Railway Signaling*, June, 1926.

In constructing a power line it was found advisable as a matter of economy and also necessary to meet the clearance condition involved in distributing power at 4600 volts, that as far as practicable, the telegraph and telephone lines be placed on the single pole line on the north side of the track and the south side pole line be reserved for signal and power supply wires. The new line was designed to be of maximum life using wooden poles to require a minimum of maintenance expense and to provide for anticipated electrical requirements for a number of years. The capacity of the line is such that current is available for operating and lighting the signal system, lighting signal stations, passenger stations, etc., and for the operation of motor-driven coaling, pumping and similar facilities on the railroad.

The voltage selected, 4600, is the maximum that may be used on a combined line with the Western Union, there being two short sections where, on account of space not being available for two lines, it was necessary t(consolidate with the Western Union. Four power supply locations were selected at points approximately 35 miles apart. Power is available at each point from the Adirondack Power & Light Corporation. The conductors are of No. 00 solid copper furnishing sufficient carrying capacity should two of the four sources of supply fail.

There are three power supply transformers of General Electric manufacture at each of the four supply stations of 37½ kva. capacity, making the nominal supply at each location 112½ kva. The power supply apparatus is arranged on a six pole structure, two poles being used to support the power company's disconnecting switches and main transformers. Four poles are arranged rectangularly to support the six air break horn gap switches. These switches, of Railway & Industrial Engineering Co. manufacture, are arranged three in multiple for the east line and three for the west l'ne, mechanically connected and operating each line sepa-

rately from the levers on the ground. General Electric Co. outdoor potential transformers with lights connected are provided to indicate the electrical condition of the line.

Approximately 9,000 long leaf yellow pine poles were purchased of J. A. Rennolds & Bro. for the installation. These were delivered by schooner at Weehawken, N. J., and re-shipped by rail to the creosoting plant at Rome, N. Y. The specifications required Class "A" poles, but the average of poles furnished was well in excess of that size. The poles were treated with coal tar creosote for approximately one and one-quarter hours under a pressure of 175 lb. Full sap penetration was obtained and an average of 10 lb. creosote per cubic foot of pole retained.

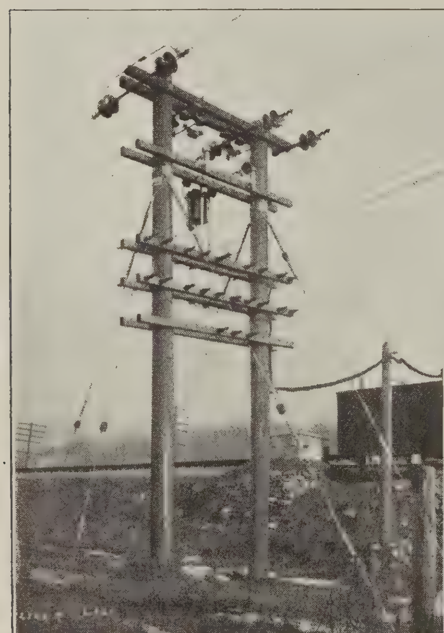
Work Involved Considerable Field Engineering

Before the poles were framed and treated a field survey was made and a pole line diagram drawn to a scale of 100 ft. to the in. prepared, giving for each pole, the distance from rail, elevation of top and bottom of pole from rail, length of pole, location of guys and framing. Key letters were given poles with similar framing, which with length of pole was stamped on a metal tag on the base of each pole before treatment. Poles of the same length and framing were similarly identified to reduce cost of handling to a minimum. The line is laid out on the basis of 60 poles per mile with "H" fixtures at transformer locations and at sharp corners, including approximately 36 guys with creosoted anchor logs per mile. One-half inch copperweld guy and messenger wire is used.

Poles are set in the ground a minimum of 5½ ft. On the side of embankments and at river banks this depth is increased to 9 or 10 ft. At a number of places poles were set in the Mohawk river and riprap placed around them to protect against flood and ice conditions. A considerable amount of rock outcropping exists along the right of way and 53 holes within a mile required blasting. At many places the anchor rods were leaded into rock.

Each pole is equipped with galvanized iron steps. When the power supply line was placed in service a white enameled sign was fastened to the track side of each pole with red letters reading "4600 VOLTS—DANGER." The signs are 3 in. by 11 in. slightly curved to fit the poles and were furnished by Railroad Accessories Corp. The power line crossarms are 4 in. by 5 in. yellow pine creosoted, 8 ft. long for single poles and 10 ft. long for "H" structures. The minimum spacing of power conductors on the line is 22 in.

Power line insulators are used mounted on ⅞-in. pins with 1⅜-in. leaded tips. The insulators are partially of the Locke Type 6508, 23,000-volt rating and partially of the Corning Pyrex glass type, 25,000-volt rating. This is said to be the first installation of Pyrex insulators in the eastern section of the country. Strain insulators are the Locke Type 5800. Galvanized strain clamps are the Pinco Type 12. Splices in the No. 00 solid copper conductors were made with 14 in. "Memco" oval seamless splicing sleeves. The sleeves were given three turns and the projecting end of the conductor cut off one-half inch from end of sleeve and turned back slightly in excess of 90 deg. Both strain clamps and splicing sleeves were furnished by the Railroad Accessories Corp.



Special "H" Frames Are Installed at Automatic Signal Locations

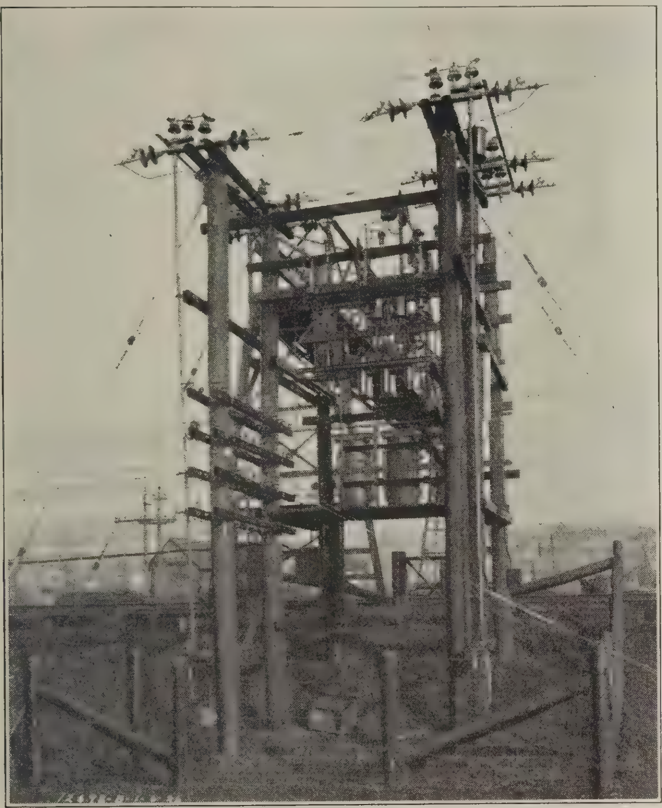
Power Line Transposition Is Effected On a Single Pole

Junction Pole Installed for Lead Cable Under Highway Bridge

Aerial Cable Used at Several Highway Bridges and Wire Crossings

In a number of cases it was not practicable to secure proper clearance over highway bridges or telephone or telegraph wires and power conductors were taken beneath in a single conductor Okonite cable. The cable consisting of No. 00 solid conductor with ¼-in. wall of Okonite rubber insulation and ⅛-in. lead sheath is supported on copperweld messenger with copperweld cable

clips. Both lead sheath and messenger are connected direct to ground wire. The connection between the open line and lead-covered cable is made through a G. & W. pothead No. 70-062 vertically mounted on the crossarm with a parallel connection to a General Electric Co. lightning arrester Form-P Cat. No. 2,515,571-G-1. Strain insulators and messenger wires are attached to E. A. Lundy Co. galvanized support angles. These support angles run transversely of the double crossarms.



Power Supply Substation at St. Johnsville, N. Y.

The question of a primary fuse was given considerable study due to the desirability of securing an expulsion type that when blown would be readily observable from the track or from a passing train and yet sensitive enough to protect on the primary side such crosses as might occur with signal circuits or apparatus. The Raymer explosive type, one-half ampere fuse with choke coil, as furnished by the E. A. Lundy Co., was decided upon. This coil and fuse is an integral part of the local branch of the sectionalizing switch. The choke coil takes the place of the switch blade, the fuse being incorporated in the contact block of the switch. The sectionalizing switches are supported on the under side of double crossarms, and arranged so that a blown fuse will cause the choke coil switch blade to move to a vertical position.

Transposition of the power line is made at required points to protect telephone circuits from inductive interference. Where the transposition point is adjacent to an "H" fixture the transposition is readily made without extra expense. At other points the transposition is effected on a single pole carrying the outside wire over other wires by means of a galvanized iron extension. This arrangement is considered stronger than barreling the line with incidental corner strains.

Steel poles were specified for use at Schenectady, N. Y., Amsterdam and Utica on account of limited clearances and along spans. It is proposed to cross the Mohawk river with a single 800 ft. span supported from 55 ft. steel towers, using No. 0000 conductors with a 42 ft. sag for the river span.

Preparation of plans and detail electrical engineering work was carried out by Ray Patterson, assistant engineer. Consulting assistance and advice were given by E. C. Keenan, general superintendent telegraph, New York Central lines, and J. T. Seaver, assistant engineer, electrical department, New York Central.

The Detroit, Toledo & Ironton Locomotive and One of the Reinforced Concrete Trolley Supports

Back Row—1.—A. J. Prettyman, N. Y. C. & N. H. R. R.; 2.—Crawford McGinnis, Pyle Nat. Co.; 3.—Philip S. Westcott, Pyle Nat. Co.; 4.—R. F. Duysters, Ry. Elec. Engr.; 5.—A. McGary, N. Y. C.; 6.—W. F. Gunn; 7.—John F. McCullough, B. & M.; 8.—P. J. Callahan, B. & M.; 9.—Frank Zimkowski, N. Y. N. H. & H.; 10.—Raleigh T. Krapp, Gould Car Ltg. Corp.; 11.—M. R. Shedd, Gould Car Ltg. Corp.; 12.—W. F. Bouche, Gould Car Ltg. Corp.; 13.—J. R. Sloan, Penn. R. R.; 14.—W. L. Bliss, U. S. L. & H. Corp.; 15.—Geo. R. Berger, Gould Car Ltg. Corp.; 16.—O. K. Hildebrant, Edison Stor. Bat. Co.; 17.—J. L. Minick, Penn. R. R.; 18.—Lewis S. Billau, B. & O.; 19.—Geo. T. Johnson, N. Y. N. H. & H.; 20.—Ed. Wray, Ry. Purchases & Stores; 21.—A. H. Adkins, Elec. Stor. Bat. Co.; 22.—W. F. Freutel, C. & O.; 23.—G. W. Bebout, C. & O.; 24.—H. J. Graham, Elec. Ser. Supplies Co.; 25.—J. M. Lorenz, Central States Gen. Elec. Supply Co.; 26.—J. O. Fraker, T. & P.; 27.—Erwing A. Freedman, N. Y. C.; 28.—R. E. Gallagher, L. & N.; 29.—Chas. P. Kahler, Oregon Short Line; 30.—D. C. Wilson, Edison Stor. Bat. Co.; 31.—Geo. H. Scott, Safety Car Heat. & Ltg. Co.; 32.—E. H. Hagensick, Pyle Nat. Co.; 33.—J. J. Kennedy, Pyle Nat. Co.; 34.—R. M. Shoop, Gen. Elec. Co.; 35.—C. L. Kincaid, L. & N.; 36.—H. B. Hamilton, Elec. Stor. Bat. Co.; 37.—C. Dorticos, Gen. Elec. Co.; 38.—H. B. Pflasterer, I. F. Bowser & Co.; 39.—T. M. Childs, Elec. Ser-Supplies Co.; 40.—Geo. E. Murray, Grand Trunk; 41.—J. E. Kilker, Mo. Pac.; 42.—J. C. McElree, Mo. Pac.; 43.—J. A. Amos, Pyle Nat. Co.; 44.—L. C. Hensel, Edison Storage Bat. Co.; 45. R. W. Eves, B. & O.; 46.—L. C. Muelheim, B. & O.; 47.—F. J. Fischer, Ry. Elec. Engr.

Semi-Annual Convention of the A. R. E. E.

Electrical Men Meet In Atlantic City for Discussion of Progress Reports of Committees

THE semi-annual convention of the Association of Railway Electrical Engineers was held in Atlantic City at the Hotel Dennis on June 14. The meeting was held on the eighth floor of an addition recently built to the hotel. Between 80 and 100 persons were present when the meeting was called to order by Vice-President Charles R. Sugg, electrical engineer of the Atlantic Coast Line, who officiated in the place of the president, E. Wannamaker, who was confined to his room at Chalfonte Hotel, Atlantic City, suffering with eye trouble.

The meeting was also marked by the absence of the secretary-treasurer, Joseph A. Andreucetti, who on account of illness was unable to come to the convention this year. A. G. Oehler, editor *Railway Electrical Engineer*, acting as secretary, read a letter from Mr. Andreucetti expressing his regrets at not being able to be present.

On account of the absence of the president and secretary, the meeting was begun without the usual president's welcome address or the report of secretary-treasurer which is ordinarily presented at this time.

The first committee report to be considered was that of the committee on Safe Installation and Maintenance of Electrical Equipment. This report was presented by George T. Johnson, assistant electrical engineer of the New Haven.

Committee on Safe Installation and Maintenance of Electrical Equipment

Mr. Johnson did not read the report, but referred to it as follows: "The Committee felt that it was advisable to get this report before the members for discussion next fall, especially the grounding part, which was brought up in our last meeting at Chicago, and, if I may, I would like to be excused from reading that part, it being so long would take up much valuable time.

"We have placed in this report an article on Resuscitation. That is something that is quite difficult to find when one wants it, so we thought it would be advisable to incorporate that in the report, and especially the treatment of electrical shock.

"The same thing applies on the grounding, and we brought to the attention of the Association the fact that most of us take for granted insurance regulations in reference to the sizes of wires. We have tried to bring out in this report the fact that that doesn't always apply, especially since larger apparatus is being used, and consequently we have given you a list of the fusing currents of the various sizes of wire so that one could apply it.

"There was quite a little discussion at the Chicago meeting in reference to the types of grounds to be used in reference to their ability to carry the current in case of grounding, so in this report we have given you the curves for the various types of pipe, the various sizes, and also in reference to the electrical resistance of the earth about these pipes.

"We have taken up the matter of grounding to water systems, where it applies, with the resistance and the method of obtaining that resistance and measuring the ground resistance.

"We have given you also the various methods of protecting these wires and also the methods of grounding either the wires or the equipment or arrestors."

Front Row—1.—Chas. J. Corse, Ry. Elec. Engr.; 2.—A. B. McQueen, New York Central; 3.—Carl P. Geis, Pyle Nat. Co.; 4.—A. E. Voigt, A. T. & S. F. Ry.; 5.—Geo. W. Wall, D. L. & W.; 6.—H. W. Beedle, Elec. Stor. Bat. Co.; 7.—Thos. L. Mount, Elec. Stor. Bat. Co.; 8.—E. H. Watkins, Elec. Stor. Bat. Co.; 9.—Frank P. Dereby, Elec. Stor. Bat. Co.; 10.—P. H. Simpson, Gould Car Ltg. Corp.; 11.—Chas. R. Sugg, A. C. L. Ry.; 12.—W. C. Leingang, Elec. Stor. Bat. Co.; 13.—C. L. Walker, Crouse-Hinds Co.; 14.—W. C. Hooven, Elec. Stor. Bat. Co.; 15.—Roland Whitehurst, Elec. Stor. Bat. Co.; 16.—L. S. Hungerford, Jr., U. S. Rubber Co.; 17.—R. E. Green, C. B. & Q.; 18.—W. F. Bauer, Edison Stor. Bat. Co.; 19.—Edward L. Pollock, Jr., Central States General Elec. Supply Co.; 20.—R. I. Baird, Elec. Stor. Bat. Co.; 21.—A. G. Oehler, Ry. Elec. Engr.; 22.—H. D. Rohman, Elec. Ser. Supplies Co.; 23.—Geo. O. Moore, B. & O.; 24.—F. H. Penny, Gen. Elec. Co.; 25.—V. R. Emrick, Florida East Coast; 26.—R. W. Cost, Westinghouse Lamp Co.; 27.—Thos. P. McGinnis, Pyle Nat. Co.; 28.—G. G. Griffin, Crouse-Hinds Co.; 29.—W. W. Booth, Crouse-Hinds Co.; 30.—H. A. Copell, N. Y. N. H. & H.; 31.—Richard Rush, N. Y. N. H. & H.; 32.—J. Henry Schroeder, Sunbeam Elec. Mfg. Co.; 33.—C. W. Marshall, Sunbeam Elec. Mfg. Co.; 34.—A. G. Pack, Jr., B. & O.; 35.—Ray N. Baker, Okonite Co.; 36.—J. H. Davis, B. & O.

Chairman Sugg: "Gentlemen, you have heard the report by Mr. Johnson. We are very anxious to get some discussion, especially on the grounding, or any other part of the report anyone has read and wants to call attention to or discuss."

L. S. Billau (B. & O.): "I should like to have the question answered, if the recommendations contained in this committee's report are harmonized with, or rather, I should say, follow exactly or very closely the proposed revised National Electric Safety Code. This will probably be made public in the very near future, and in case we differ in places, it would seem to me that the committee would want to give rather careful consideration to harmonizing all the way through unless they have very good reasons as to why they feel in certain details we should deviate, assuming that in time the requirements of the National Electric Safety Code will become of more or less widespread use."

Mr. Johnson: "Mr. President, the Committee before taking up this subject of grounding looked through the Safety Code, the reports of the National Board of Fire Underwriters and all information they could obtain in reference to grounding. The safety code in fact is taken from the National Electric Code, and I think that we have followed that and the various codes pretty closely."

Committee on Loose Leaf Manual

In presenting the report, Mr. Billau, the chairman of the committee, said, "The committee regrets that, due to circumstances which have been more or less unavoidable, that the Manual of the Association is not in your hands at this time. It was expected last fall that it would be distributed at about the same time of the proceedings, but various things have come up that have delayed it, but it is expected now to have it in the hands of the printer within the next week or ten days, and it should be ready for distribution, we hope, during July.

"I think the subject has been covered so many times as to what the Manual will include, the purposes, and so forth, that it will be unnecessary to go all over that ground again this morning.

"I do want to leave one word with you, particularly with the chairmen of the various committees. In reviewing the proceedings of the Association with the view to putting the various standards and other recommended practices in shape for insertion in the Manual, the Committee found it very difficult because of the form of wording and in many cases had to re-edit it to put it in shape for the Manual. In this first attempt our committee has felt that we should make as few changes as possible. Of course, we have no authority to change the sense of the recommendation, but it is hoped that the committees from now on will give more attention to that phase of it in submitting their reports. In this connection I think it would be very desirable that each committee include as a part of its report a specific recommendation covering the new matter that should go into the Manual, and in which case they ought to put the information in the form in which they would desire it inserted in the Manual. Secondly, revision of any existing subject matter, and, thirdly, any subject matter that should be removed from the Manual.

"You have all received through the Secretary-Treasurer letters advising how the Manual will be distributed; the binders, which will be practically identical with the style of binder that is used by the Mechanical Division of the A. R. A. and also by the Signal Section of the Engineers' Division, will be sold at practically cost price to the members. The sheets to be incorporated in the Manual, covering our standards and practices, will be issued to the members each year without charge and to non-members will be sold at rates which will be established." There was no further discussion.

Committee on Illumination

Mr. Billau also presented the Report of the Illumination Committee, speaking as follows: "The report of the Committee on Illumination this year will be largely a continuation of the work started last year. As outlined in the published report, we will continue inserting the tables or data showing the production of incandescent lamps in schedules that are used largely exclusively by the railroads, that is, train lighting and locomotive head-

lighting schedules. The committee has felt that information of this character is very valuable to the users of the lamps to show the trend of the newer types of lamps. Where these changes that are taking place, as at present, from older lines of lamps to the newer lines, it assists in bringing these about more rapidly.

"I am sure you all recognize the advantages in the adoption of the simplified lines of lamps in their broadest sense, which means not only these newer types, but also reduction in the range of voltages and other factors which are in the long run to the advantage of the railroads.

"The next subject that the committee takes up and which will be the main work of the committee this year will be the continuation of the study of flood lighting of railroad yards. It is expected this year to have more specific recommendations and data, based on the results obtained in some of the latest installations of floodlights.

"Along with that, a subject has been assigned to the committee, which is one of vital interest to all, the question of a lamp for floodlighting use. The subject is being considered from two points of view—first, is there a need for a special lamp for floodlighting service such as is met with in a modern large railroad yard, and, second, if there is no need for a special lamp for this purpose, the committee desires to arrive at some other type of lamp which all will agree represents the most satisfactory type of lamp for the purpose, which lamp should be designated as a floodlighting lamp. In this connection, the committee would be very glad to receive suggestions from the members.

"The other subject that the committee is handling is the headlight lamp work. The committee is working closely with the Locomotive Lighting Committee. You will recall the subject as left last year. The Association approved or placed on the approved list the S-14 bulb cab lamp. From such information as gained thus far, it appears the railways are rapidly changing over to the use of this lamp.

"The other subject that was left incomplete last year came up in connection with the change from the spherical type bulb to the peak type bulb for the locomotive headlights, and as most of you know, the 100-watt switching service lamp and the 250-watt road service headlight lamp are now available in the same size of bulb. There has been serious objection on the part of many to this practice on account of the possibility of confusing the lamps. As a consequence, the lamp manufacturers have offered various suggestions as a means of marking the lamp for identification. One method of marking the lamp in the switching service is with a heavy broad edged band near the tip of the lamp around the molding. Another type of marking that has been tried out only experimentally is an inside frost lamp, and it is with respect to this lamp that I will devote a few minutes this morning.

"Two railroads that I know of have made some rather informal tests, using the inside frost 100-watt lamp. The tests have been altogether too meager to consider these conclusions at all as final, but it would appear that the greater diffusion of light obtained with the inside frost lamp, the reduction of serious glare, make the lamp rather desirable from the operating point of view, irrespective of the question of distinguishing it from the clear bulb lamp used in road locomotive service.

"From the point of visibility, obviously, in a lamp of this type the beam candle power is greatly reduced, and the tests indicate that the requirements are met, but with rather close margins, and it might be found necessary after further tests are made, that the wattage of the lamp may have to be increased somewhat should this type of lamp be used to any appreciable extent.

"In the train lighting field, there is very little to be said. The new line of lamps is available commercially."

Mr. McGinness (Pyle National): "One of the few tests of the 100-watt frosted bulbs for switch engine service was made when I happened to be present, and I was very favorably impressed with what I saw. In view of the fact that two roads making the tests came out so nearly the same, it would seem that the question of distance is not serious. I think it is a step in the right direction and it is going to stop a lot of trouble that has been noticed in different parts of the country and around which no one has been able to get."

Frank Zimkowski (N. Y., N. H. & H.): "As Mr. McGinness said, we are working in the right direction. We made a test of this new lamp on our road and the men all seemed to like it as it seemed to overcome a lot of trouble. Although, as Mr. Billau says, the margin is small and it must be built to a higher wattage."

Chairman Sugg: "Mr. Billau, was there any test made on the glare with the use of that lamp as compared with the other lamp?"

Mr. Billau: "The tests that were made were very informal and meager tests. The time was limited as well as the facilities. The tests that I am most familiar with were simply visibility tests of the usual kind and also some observations made by a member of the operating department and others, in getting out in front of the headlight and looking toward it with the inside frost lamp in the headlight, and with the clear bulb."

Mr. McGinness: "While we are still on that subject, one of the most interesting things that I noticed about that lamp is the ability to get the same delineation of beam at almost any position of the lamp, that is, within the range of focusing. That is where we have always had to consider the source of light. Mr. Zimkowski, and I think some of the other gentlemen went into that and made tests to get some idea of what difference that made, and to our surprise we could move that lamp around at will and it would make no change in the delineation of the beams."

Mr. Johnson: "The train crew around in the yard were impressed—it appealed to them very strongly. They were very enthusiastic over the frosted, brand-new lamp. I think if we ever put them in the yard, we will never be able to get them out."

Chairman Sugg: "Are any of the representatives of the lamp manufacturers present? Mr. Broe."

A. L. Broe (Edison Lamp Works): "From what tests have been made so far, the thing does look rather promising and the only question that has come up in my mind is whether you have enough margin over the 300-foot requirements so that you will be on the safe side when you allow for the various factors of depreciation which occur during operation. The lamp manufacturers will be glad to supply the lamps, and if the tests prove

you have to go to a little higher wattage the wattage can be put in that bulb without any difficulty."

Mr. Cost (Westinghouse Lamp Company): "So far as depreciation is concerned, I don't think you will find any more depreciation in that particular type of bulb than in the clear bulb that is being used."

P. S. Westcott (Pyle National): "I wonder, Mr. Billau, if it isn't important to consider the proposed reflector in connection with the frosted bulb. I notice that many roads have turned to the enclosed bulb to get away from glare, but the efficiency is quite low, and the inside frosted lamp may change that situation."

Mr. Billau: "So far as I know, no careful tests have been made in the way of determining actually the difference in illumination of a car, using the clear bulb and the illumination secured when using an inside frosted lamp. I feel the only reduction in the light output of the unit as a whole will be in the same proportion as the reduction in the light output of the lamp by itself."

Mr. Voigt: "In connection with this report, I would like to ask the lamp manufacturers if the general trend in the car lighting field is to go to the anchored type of filament in the 50-watt lamp?"

Mr. Broe: "I think the anchor type of filament is standard now for the 50-watt lamp."

Mr. McGinness: "Mr. Chairman, I think the keenest interest in standardization of floodlighting lamps is highly justified but I would like to suggest that the committee recognize the fact that floodlight manufacturers use floodlight projectors for a number of other purposes besides railroad yard lighting, and some movement has been made by other organizations to standardize on floodlighting lamps. One has recently come to our attention, that is, the U. S. Army Air Service, who have decided on a particular type of lamp for floodlighting as a standard lamp. So if the committee will find it possible to investigate the efforts made by these other organizations in the same direction they may find something of interest to include in their own report."

Mr. Minick: "The railroads haven't much opportunity to find out how many and what size units are being used in other classes of service. The people who can furnish that to the railroads conveniently are the manufacturers of the floodlighting equipment, those who make and sell this equipment, they can give us some idea of the number and sizes of the units actually in use today." The report was accepted.

Motors and Controls

The report of the Committee on Motors and Controls was next presented by George W. Bebout, electrical engineer of the Chesapeake & Ohio, who spoke as follows:

"There is not much to say except we are working on the Motor and Controls studies. After we have another meeting we want to have a meeting with the power committee and go over their proposed report. They have been a great help to us in former reports and we want to work with them in the future.

"In our motor specification, we want to meet Mr. Minick and some of the others that are on the other motor committee and try to get their specifications more nearly to conform to the A. R. E. E. report. We don't want to get something that is special and cause the manufacturers to have to build something special for railroads, but we do want to get the best thing there is on the market." There was no discussion.

Train Lighting

The next report to be presented was that of the Committee on Train Lighting. P. J. Callahan, supervisor of train and locomotive lighting on the Boston & Maine, chairman of the Committee, read the report.

Mr. Voigt of the Santa Fe opened the discussion saying, "I feel somewhat guilty in not having said something to Mr. Callahan. I was unable to attend his last committee meeting, but that clearance allowance for the car body of one inch, I do not feel would be sufficient for the use of a clamp or a Safety fastener. Then on a truck-supported machine, I am in favor of the clearance given there, but I wonder if there has been an actual check made of the various types of trucks. We have to be certain that we can get three inches over the end sill and at the same time get the three inches over the brake beam with the fish body construction."

Mr. Bouche: "We would like to get all the clearance we can on all the revolving parts, but I think there should be some discretion exercised. The reason I rise to make any remarks at all is that a good many will get these recommended practices, and regardless of what the trucks look like and the brake rest, they will ask the fellow hanging generators on the car to give this clearance asked. If it was put in the form where the minimum was stated and anything greater than that recommended, permitted, I think it would greatly clarify the problem."

Mr. Callahan: "I don't believe the committee has any objection to handling it from that point of view. The present specifications are entirely out of date and the chief idea was to bring in something that would cover it to some extent and allow the members to comment on it and make any suggestions that they saw fit."

Mr. Sloan: "I would suggest that the committee look at it from this angle: That the clearance required from the inside is one thing and that required on the outside is another. You can allow very much less clearance for the inside surface of the belt than you can for the outside surface."

Mr. Voigt: "I would just like to ask the chairman if the A. R. A. at one time did not have in their recommended practices the fact that we should use a rough-turned base axle where the axle pulley is mounted? It seems to me that this subject has been covered in the A. R. A. and was accepted by them."

Mr. Sloan: "Mr. Chairman, I am pretty positive it was in there." Report accepted.

Chairman Sugg: "There has not been any written report forwarded by the Headlight Committee, but I understand Mr. Muelheim is ready to make a statement or report, and if he is present I would like to have him present it."

L. C. Muelheim (B. & O.): "The Committee has no report to make at this meeting, but we hope to have a final report for the fall convention."

Chairman Suggs: "The Acting Secretary has received this morning a letter from Mr. Lunn, chairman of the committee on the Application of Radio to Railway Service. I will have Mr. Oehler read this letter."

Acting Secretary Oehler: "This communication

from Mr. Lunn, addressed to Mr. Andreucetti, reads as follows:

Mr. Jos. Andreucetti, Sec.,
Association of Railway Electrical Engineers,
Chicago & Northwestern Railroad Depot,
Chicago, Illinois.

Dear Sir:

The committee on application of radio to railway service has no progress report to submit at the Atlantic City mid-year convention.

Nothing startling has been developed in this field of research since the October convention last year, which was not to some degree anticipated at that time, although a large number of applications to passenger cars have been reported with varying success.

The demand for radio reception on trains is but the reflection of the public interest in that form of entertainment and instruction, everywhere in evidence, enjoyed by some and objected to by others. While endeavoring to keep in touch with all phases of the radio question as it relates to passenger trains, your committee is particularly interested in the problem of determining what type of make of receiver gives best results and in the most satisfactory methods of making the installation. Incidentally and from a distance it is concerned in the extent to which radio equipped trains attract patronage.

No promises are being made as to what will appear in the annual report, but a statement of facts concerning the status existing at that time may be of interest and it is hoped serve as a guide to those who may be called upon to superintend installations.

Yours truly,

Ernest Lunn.

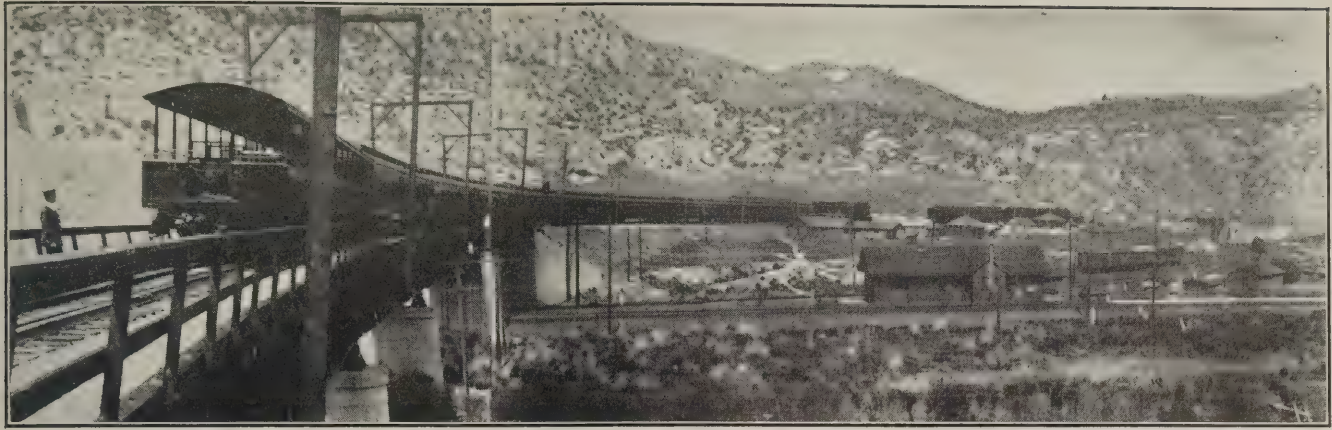
Mr. Westcott: "Mr. Chairman, since having been associated with that work, I have been trying to follow the application of radio to trains. Since Mr. Lunn's report to you, a matter came up with reference to the work of the Pennsylvania, that I do think is important to bring out. To date, most of the applications have been of purely an amusement character, but the railroad electrical engineer will soon be confronted with the problem of applying the radio to railway service in terms of signaling. That is, the handling of trains by means of radio communication between the members of the crew. Application of radio of an amusement nature is of very minor importance and the real value of radio lies in terms of establishing communication lines in conjunction with movement of rolling stock. The methods of communication in the past have been entirely out of the province of the railroad electrical engineer, inasmuch as the devices involved the use of air and steam, but now that it becomes entirely possible to communicate by means of electrical devices and in particular through the medium of radio, it immediately becomes a very important part in the future of the railway electrical engineer's functions.

"In this connection, I wish to call your attention to a test conducted by the Pennsylvania Railroad to determine the possibility of connecting the cab of a locomotive and the caboose of a freight train. On a 73-car train in a seven and a half hour running time a full hour of running time was cut down, due to the ability of the engineman to communicate by phone to the caboose with the freight conductor."

Mr. Bebout: "I think this matter of the application of radio to communication between cab and caboose should be carefully studied. On our lines through the mountains, handling from 80 to 100 cars, the caboose and cars around quite a number of curves between them and the cab of the locomotive it is practically impossible for them to get signals and some kind of communication, which would speed up traffic considerably is highly desirable."

The meeting then adjourned to the lawn of the Hotel Dennis, where the group photograph shown at the beginning of this report was taken.

One of the Virginian Locomotives at the Head of a 6,000 Ton Train on the 2 Per Cent Grade Between Mullens and Clarkes Gap, W. Va.



Chicago, Milwaukee & St. Paul Train on Electrified Section at Logan, Montana

Requirements for Present Day Car Lighting*

Types of Equipment and Quality of Maintenance are Vital Factors for Satisfactory Illumination

IN view of the almost universal demand on the part of the traveling public for better lighting in railway equipment, those having to do with this particular branch of the service must of necessity give it continual thought and study to bring about the desired ends. A careful study of the relative costs for furnishing suitable electric lighting must be made especially so where railroads still offer oil and gas lighting to the traveling public. We feel that in order to accomplish this a suitable design of headlight generator, or in the case of motor cars, properly designed mechanically driven units in conjunction with batteries, will have to be furnished.

In order to obtain the desired end under any plan the following factors are essential:

1. A suitable method of installation.
2. Proper voltage regulation so as to give uniform lighting.
3. A proper design of equipment.
4. An adequate program of maintenance.
5. A reliable check on conditions and requirements.
6. A systematic program of judging current public requirements and desires.

Method of Installation

The first thing to be given consideration in connection with the installation is the class of material needed to meet the requirements, such as insulated wires and cables. The manufacturers have given careful thought and study to producing electrical materials, and the products now on the market appear entirely satisfactory.

In the handling of the wiring, good workmanship is necessary and of great importance. The joints and splices must be made mechanically strong in applying wire to railway equipment, as it is at these points that the insulation usually fails. After a good mechanical contact has been made and soldered, the joint should be carefully wrapped with tapes to make this particular part of the insulation as permanent as is possible.

Due to the burrs going toward the inside of the conduit while being cut, it is important that the inside of the ends be properly reamed. Where the conduit ends or enters into fittings, they should be protected by an approved bushing. The ends of the large conduit in which the main wires are run should be fitted with an insulated bushing as it is at this point where most failures occur due to the vibration of the car when in operation. It is felt that too much care and attention cannot be given to this particular part of the work. Conduit should be so arranged, and enough pull boxes put in, so that it can be made up and the wires pulled in afterwards. This method of application is suggested as it seems to provide for a better condition of maintenance and overcomes considerable cost in handling repairs.

The main switches and fuses, and branch switches and fuses, should be mounted on either a marble or asbestos ebony board and the whole placed in an iron cabinet. This cabinet is not necessary if the switch panel is placed in a locker in the car. However, when such lockers are used they should be properly insulated with suitable asbestos covering. Single pole switches, placed at various parts of the car to control single units, should be mounted on a metal plate, properly fitted over the junction boxes in which the wires are located.

This system of conduit is more necessary in an all-steel car than in one of composite design. Great difficulties are experienced in providing the all conduit system in cars already in service, and in some cases it is found to be practically impossible to install the full system. In building new equipment, it is an easy matter to provide a complete conduit system, and same can be properly installed at little expense. It is, therefore, essential that car designers cooperate to the fullest extent with electrical engineers so as to provide proper plans for the installation of the electric wiring.

Proper Voltage Regulation So as to Give Uniform Lighting

When electric lamps are manufactured they are of a pre-determined or fixed voltage. It is necessary to furnish this voltage if the rated candle power of the lamp

* Submitted as a discussion of the report on Locomotive and Car Lighting presented on June 15, 1926, at the American Railway Association Convention in Atlantic City by C. G. Juneau, Master Car Builder, Chicago, Milwaukee & St. Paul.

is to be obtained. This can be accomplished in the axle design generator by an automatic voltage regulator or by a hand rheostat in the baggage car on such trains lighted under the head-end generator system. On locomotive turbine headlight generators the voltage is controlled by the speed governor of the turbine and in the windings of the generator. The regulating of the voltage is well taken care of by the manufacturers of car lighting generators and when conditions are normal good results obtain. One thing that is often overlooked by the layman is that an overloaded generator will not hold up its voltage and the natural result is poor lighting. This is caused by the turbine operating the generator slowing down in speed or, in the case of the axle driven generator, the slipping of the belt. When new turbine or axle generators are purchased it is essential that careful study be made of the load the generator is to carry, and in addition to provide for a suitable factor of safety. This is one of the most difficult problems confronting electrical departments in this present day, especially on locomotive head-lighted trains, as it is the practice of the transportation department to increase the number of cars in the train, which naturally places a greater load on the turbine. This is what makes it necessary to provide a factor of safety in order to meet an overloaded condition.

Uniform lighting throughout the train is important and it is felt this is more nearly accomplished by head-end dynamo baggage car turbine generators than by axle devices. The reason for this is that a baggage car generator, lighting the whole train at the same time, sends sufficient current into the batteries to cause them to float on the lines and stabilizes the voltage. Uniform lighting not only demands good voltage regulation but also the right number and proper placement of lights in the car.

Proper Design of Equipment

The important factors to be considered, and which are essential, are:

1. Artistic design and arrangement of fixtures.
2. Efficiency of maintenance.

There does not seem to be much chance of artistic design in the present construction of all-steel cars except in the general lines of the upper deck. There is more opportunity in the lighting fixtures but here we again find that efficiency of maintenance in a measure blocks design. We are inclined, generally, towards plain fixtures of smooth lines and surfaces, except in dining, parlor and observation cars. Sufficient latitude can be taken insofar as fixtures are concerned to provide pleasing designs, keeping in mind at all times that patrons of railroads, to the majority of cases, like an abundance of light.

Proper Maintenance Program

The problem of maintenance of equipment always confronts us. It entails proper organization of shop and terminal forces and the proper educating of terminal forces where daily inspections and running repairs are made, for the reason that unless this part of the work is properly handled much damage and embarrassment results. As a matter of fact practically all railroads have an individual method of handling the maintenance of equipment.

Reliable Check of Conditions and Requirements

It is important that originating terminals give proper attention and inspection to lamps, generator regulators, both axle and head-end baggage car generators, wiring, and electric fans, also the storage batteries. All of these must be tested daily before leaving the originating point. Careful record should be kept on suitable forms which will provide proper information as to the conditions and will also be an indicator to the shop forces as to the general conditions found in operation and better enable them to determine defects should difficulty be experienced, without the necessity of a great expenditure of money when cars are shopped. Such records will also in a measure expedite the work when cars are in shop.

Many interesting articles have been written on the subject of passenger train car lighting and its maintenance. In an article appearing in the *Railway Electrical Engineer,* March, 1926, issue, W. J. Dawson, electrical engineer of the Kansas City Terminals, gives some interesting information on their method of handling this important work. The Kansas City Terminals having a large field in which to work on account of handling both axle and head-end lighted cars, Mr. Dawson has been afforded an opportunity to study the efficiency of practically all classes of equipment, and those who have not had an opportunity of reading this interesting article will be greatly benefited by obtaining a copy and studying over what has been said on the subject.

Another article appearing in the *Railway Electrical Engineer* in the issues of both February and April, 1926, by G. W. Wall, car lighting foreman, D. L. & W., brings out some interesting facts in connection with car lighting maintenance.

In the December, 1925, issue of the *Railway Electrical Engineer* there is an article on the practices followed on the Southern Pacific on axle car lighting maintenance. This dwells mostly on the operation and maintenance of 800 axle light generators, a large majority of which are body hung. A feature worth noting is that all pulleys are mounted on the center of the axle. The use of a 14-in. face pulley with 2-in. flange is provided. It seems to me that this width face pulley provides a suitable condition and is a happy medium between the 10-in. pulley now quite generally used and the 25-in. and 28-in. pulleys that are being experimented with to a great extent. They have also gone into the subject of belt clearances carefully, having located truck frames and brake beams so as to meet belt requirements, thereby reducing maintenance cost on this item. It is found in the operation of the axle generator equipment that lost belts constitute one of the greatest expenses, and also cause light failures which naturally brings considerable criticism from the traveling public.

Railroad Car Lighting from the Locomotive Headlight Generator

This system lends itself to a lighting field that has been more or less neglected. The people in the smaller towns on our railway are beginning to complain bitterly of the poor lighting obtained from oil lamps which are universally used in this service. Suburban trains have been pretty well taken care of on most roads but the branch line trains that reach out into farming districts demand immediate attention.

Our experience with this system of lighting proves

that it costs less for operation than keeping up oil lamps and the satisfaction given to our patrons is such that a reasonable expense can be gone into to increase the use of electric lighting on branch line trains.

Lamp, Belting and Battery Costs

Electric lamps probably constitute one of the greatest items of expense in car lighting. There are several reasons, *i.e.,* rough handling of cars breaks many, variation in voltage of the generators, careless handling by employes and operating the voltage above the rated voltage of the lamps. Unfortunately this latter condition is more severe on head-end baggage car generator lighted trains than in axle generator equipped cars. On account of the drop in the main wires of a long train—12 cars—800 to 850 ft. long, the voltage of the head-end generator has to be carried from three to five volts higher than the lamp voltage. Although a three-wire loop return system is used and theoretically the voltage should be the same at the rear of the train as in the front cars, this is not the case on account of the overloading of the train wires on a 12-car train, and the lamps in the front cars burn out sooner than those in the middle or rear cars. However, when one considers that we have in service on our road about 36,000 lamps in cars, there is a great opportunity for breakage. While we are continually calling the attention of our yardmen and baggagemen to the care of electric lamps, there is still room for improvement.

Axle generator belting is a serious expense on axle lighted roads but these roads are continually working on this problem as articles already referred to point out.

The storage battery is our greatest expense in operating train lighting and the principal reason is the over-discharge that they are continually subjected to. This resolves itself into an operating condition that can be overcome to a large extent by a larger investment in batteries in order that there will be enough batteries on the trains so that they can carry the lamp load without becoming over-discharged.

You all probably know that sulphation of the battery cells does the greatest amount of damage to them and begins to act when the battery is discharged down to 57 volts in a 32-cell battery and 27 volts in a 16-cell battery, and becomes more active as the cells are further discharged. Bad sulphation in a battery can only be overcome by long charging and if thoroughly done, requires that the battery be taken out of service and great expense incurred.

Illumination of Steam Passenger Cars

"Light and not lamps determines economy of car lighting"—E. E. Dorting, lighting engineer, Interborough Rapid Transit Company, New York, Electric Railway Journal, July 13, 1924.

While Mr. Dorting's article is entirely devoted to the lighting of street railway cars, using five lamps in series, his digest of the matter is most complete and convinces one of the value of such a study.

His first sentence "Light and not lamps" applies to the lighting of railway passenger cars with equal force and it is along these lines that railway men have been working of late years. The manufacturers have greatly aided us by continually producing better lamps and better reflectors and by cooperating with us in tests, etc.

It is generally conceded that single, large lighting units located in the upper deck of the car, while perhaps not giving as even an illumination as a large number of smaller lamps, are satisfactory. The first cost and the maintenance is so much lower that it better meets present day efficiency.

These large lamps are generally enclosed in a semi-opaque bowl to prevent glare. The disadvantage of excessive glare is generally understood, but a recent test made with open front berth lamps brought it out so forcibly that the matter is worthy of mention. Our test was made in a sleeper equipped with open front berth lamps using 25-watt, P. S. 16 clear lamps, 3½ candle feet being the average light obtained. In the next car of the same design and color, with enclosed front berth lamps, using the same globes and carrying the same voltage, nearly six candle feet were read on the photometer. This was brought about simply because the glare from the open front berth lamps caused the eyes of the operator to contract to such an extent that he was unable to read the photometer correctly.

Wishes of the Public Should Be Met

The question of proper lighting for passenger cars is, from the standpoint of satisfactory service, an important one. It takes rank with questions of safety of train operation, speed and adequate temperature control. The lighting of a passenger car is one of the first things noticed by a passenger in case it is not proper. On the other hand good lighting is taken so much as a matter of course that on a passenger train it attracts no attention except from the most observing. The traveling public demands greater comfort and more luxurious surroundings than in the past and, whereas some years ago sufficient light to enable the passenger to see his way through the car was acceptable, today cars must be as brilliantly lighted as the homes in which the individuals live. This has forced greater attention to this subject. The improvement has been gradual and it may be expected that the future will demand even greater attention to those items that make for greater comfort to the travelers.

Adequate and proper lighting conditions involve the type of equipment, source of supply, design of fixtures and the proper use of the equipment provided. The type of equipment is of minor consideration because in these days the electrically lighted train is almost universal. In some cases oil and gas are still used to more or less extent, but such cases are too few to be of general interest. Likewise the source of supply is almost universally the axle generator system. A few cases still exist where the head-end system is in use but these cases are rare. They are of importance, however, because there is some tendency to use the head-end system for the lighting of branch line trains and suburban trains, using the headlight generator for the dual purpose of lighting both the locomotive and train.

The design of fixture is of considerable importance, particularly in those cars provided for passengers who pay for special consideration. The fixtures should be such as to harmonize with the other parts of the car, should be artistic, and of the proper design technically to give most efficient light and at the same time be easily maintained. The artistic sense varies from time to time and this should receive consideration in providing the

fixtures because it may be found necessary to change them, after a few years' service, for a fixture that will be in keeping with the trend of the times. The location of the individual fixtures within the car demands attention in order that an efficient and pleasing lighting arrangement will be obtained.

The maintenanec of the lighting equipment for passenger train service must be of very high order. In order that the equipment may be maintained in this manner without excessive expense requires special consideration to the material and workmanship which goes into the making up of the lighting system—including the generator, the belt which drives it, the batteries, switchboard, fixtures, conduit and wiring. Too careful consideration cannot be given to the quality of insulated wire used in the manner in which it is installed. Trouble is often experienced through installing conduit in a manner that tends to collect moisture, either from direct entry or by reason of condensation. The batteries are worthy of expert attention, otherwise they will not be maintained in a condition that will render them available for 100 per cent service when they are called upon to meet an emergency. Unless properly maintained, their efficiency is greatly affected and you have a condition where comparatively great weight is hauled around which is of no practical value.

As previously mentioned, the lighting of a car is one of the things that comes in for close scrutiny of the traveling public. It is therefore of extreme importance that some agency be made responsible for keeping in touch with changes that come about in matters of artistic sense and be prepared to offer suggestions for the altering of existing equipments to keep them strictly up to date. Unless this is done a car will soon take on the appearance of an old model and is likely to create adverse opinion.

As to the matter of lighting certain trains from a large capacity headlight generator, this is found in some cases to be an economical procedure and satisfactory lighting is entirely possible. This system avoids much of the maintenance expense involved in other systems but close maintenance standards must obtain to bring about satisfactory lighting conditions, Entirely satisfactory results have been obtained with this system in trains consisting of coaches, dining cars, sleepers and parlor cars.

Utility Companies to Encourage Purchase of Power by Railroads*

The subject of electrification of steam railroads is one that in its larger aspects might more properly be considered by and dealt with by the electrification committee of the steam railroads, leaving to us to consider that phase of the problem which more directly concerns our own operations. This point of view was made manifest at the meetings of this committee which was composed of about twenty representatives, half from the steam railroads representing them rather as individuals, and half from the electric light and power industry. And in these meetings, the greatest interest was manifested by the steam railroads in discussing and considering the attitude which the electric light and power companies were taking and in the future would be likely to take toward promoting railway electrification.

It is giving weight to that point of view that the presentation as it will appear in the railway electrification committee's report will be presented to you.

It is, of course, evident that no very hard and fast line can be drawn as to the rates which it will be possible to make for steam railroad electrification. We all know how very largely that will depend upon the local conditions, the amount of traffic, load factor involved, the character of the current power demand, its point of delivery and a number of other obvious elements. Therefore, it would be, of course, hopeless to undertake or even speculate on anything like a general statement as to the probable cost of power. At the same time, there are certain fundamentals which it was felt by the committee could be formulated in the kind of a statement of fundamental principles on which this approach should be based.

And while it was not, of course, very easy to obtain a consensus of opinion between our friends of the steam railway and those engaged in the electric light and power industry, an attempt has been made to formulate these fundamental principles and they will be presented to you very presently.

Of course, we should not expect that the steam railroads would be content to have them considered on the same basis as an ordinary commercial or industrial consumer, in the way that is not demanded under our regulatory laws.

In most states, the contracts or bases, the schedule on which railroad business is done, do not enter as a part of the published schedules. In some cases, they are not directly submitted for approval before they become effective. To the public service commissions, in some cases, these are only filed with the commission after the contracts have been made. This don't imply, of course, that they are not in their final result subject to the scrutiny of the public service commission as to their reasonableness and as to their general effect on the public service as rendered by the utility as a whole.

The railroads, of course, have different criteria as to continuity of service, as to the regulation of the service that prevails in some of our larger communities. They cannot, of course, expect, except in unusual cases, to give us the same load factor as the utility companies in our larger cities have been able to reach, due to the diversification of services connected to their systems.

In most cases, they are ready to give us all the load they have, and that is about all we can expect from any customer.

Referring for a moment to the report which I, in accordance established with this convention, shall not attempt to read, it is sufficient to say that the report traverses some of the more recent electrifications from which it appears that of the various important railroad electrifications prior to 1925, of which there are about fifteen in number, eight secured all of the power required for their railroad purposes from electric utility companies, and as an important part of the report, you will find submitted with it a table in which these railroad electrifications are analyzed, more particularly with regard to the character of the service rendered, the study of the maximum demand, the methods of measurement, the exemptions from

*Report of the Electrification of Steam Railroads Committee presented May 19 at 49th annual convention of the National Electric Light Association at Atlantic City, N. J.

unusual demands. And here one at once sees the very great difference that exists in measuring that formidable factor in almost all of these contracts, the maximum demand. In some of them, the contracts will be found to have a five minute demand, others fifteen minute demand, others an hour demand. In other cases, the demand is in some cases a monthly demand. In other cases, the maximum demand lasts for a year. In other cases, it is a diluted demand, the three heaviest days in the month being taken. In others, there are certain exemptions due to unusual conditions.

It is certain that these extraordinary diversities of conditions in which these matters of measurement of demand are approached must cause a great deal of uncertainty on the part of the railroads as to the conditions that a reasonable and proper contract should cover. And I think you will all agree that some of the requirements as to measurement of the demand carry us back to our practices in our commercial relations ten or fifteen years, and should certainly permit of a broader and more liberal standardization.

I think these are matters which a future committee should take up with a view of arriving at a rather more conservative basis on which these matters should be formulated.

I wish now to have the privilege of presenting a statement of principles which the committee has reason to believe would be a forward step in improving the relations between the steam railroads and the power companies. To many of us, some of these statements may appear to be somewhat axiomatic. To others, they may be perhaps a liberal interpretation of what is being done in some of the cases of larger electrification. But, as a matter of fact, it has been felt by the railroads that some such formulation should be undertaken, and it is felt by the railroads that a declaration of policy along the lines that have been here suggested would be useful and would make for a better understanding between the steam railroads and the operating companies.

The committee, therefore, begs to submit the following:

Whereas, There is a growing field for the application of heavy electric traction as a substitute for steam upon trunk line railroads and in terminals, and

Whereas, It has been the policy of some steam roads to construct and operate their own power generating stations, which greatly adds to the investment cost of railroad electrifications, and

Whereas, The concentration of large capacity generating stations and the community of interests in high voltage transmission lines of uniform voltage and frequency has made available large and reliable generating and transmission reserves, and

Whereas, The application of heavy electric traction upon railways will depend almost entirely upon the economic justification for its investment, and the power producing companies desiring to co-operate in the application of heavy electric traction upon railways.

Be it Therefore Resolved by the National Electric Light Association that, as the basic principle of negotiations for the furnishing of power to railroads for heavy traction, it declares that the member companies should be willing to undertake to furnish under long term contracts (subject to a reasonable revision clause) the required quantities of electric power for railroad uses, in any form that may be desired by the respective railroads, either at suitable points of delivery at roadside distributing stations, upon the basis of a contract rate which will include only the actual costs, including retirement expense, involved in the delivery of the current to the points requested and an agreed-upon rate of return upon the necessary investment, including profit.

Motor-Generator Type Locomotives Being Built for the Great Northern

Two motor-generator type electric locomotives, similar in general to those being secured by the New York, New Haven and Hartford Railroad, are being constructed by the American Locomotive Company, Schenectady, N. Y., and General Electric Company, Schenectady, N. Y., for the Great Northern Railway. The two locomotives weigh 250 tons each with 200 tons on the driving wheels. They are to be used in connection with the extension of the railway electrification from Skykomish, Wash., to Wenatchee, Wash., a distance of 80 miles. In connection with this extension of the electrification, a 7¾-mile tunnel is being constructed through the Cascade Mountains, which will lower the present summit 500 feet. The new line will substitute 9 miles of practically straight track for 18 miles of very curved and heavy grade line.

The tractive power of the locomotives is exerted by two 3-axle trucks, each equipped with three 750/1,500-volt direct-current motors. Power will be received through a pantograph trolley from the 11,000-volt, single-phase, 25-cycle line, transformed to 2,300 volts and then converted through a 2,500-kw., 3-unit, synchronous motor-generator set to direct current.

Each motor is connected to the axle through twin cushion type gears. Two motors are permanently connected in series. The three unit set consists of a centrally located motor with a 1,250-kw. direct-current generator at each end. By means of guiding axles at each end of the unit, provisions are made for operating at speeds up to 40 miles an hour, with a maximum emergency speed of 50 miles an hour. Type PCL control is provided, with arrangements for multiple-unit operation of the two locomotives.

Regeneration will be obtained by controlling the excitation of the traction motor fields. The use of regeneration permits the use of the motors as a brake, the power generated in this way being fed back into the transmission system.

A high speed circuit breaker is used to protect both the locomotives and the supply lines from short circuits. The two pantograph collectors will have a range of from 16½ to 26 feet—one being used as a spare.

The maximum tractive effort of the locomotive, based on 30 per cent co-efficient of adhesion, is 122,940 pounds. The following are the principal weights and dimensions:
The following are the principal weights and dimensions:

Length inside knuckles	73 ft. 6 in.
Length inside cab	61 ft. 0 in.
Height inside cab	13 ft. 11 in.
Height over trolley locked down	15 ft. 3 in.
Total wheel base	60 ft. 0 in.
Rigid wheel base	15 ft. 10 in.
Total weight	509,800 lb.
Weight on drivers	409,800 lb.
Weight per driving axle	68,300 lb.
Weight per guiding axle	50,000 lb.
Diameter of driving wheels	54 in.
Diameter of guiding wheels	36 in.

Substation Equipments

Arrangements have also been made to convert the Puget Sound Power and Light Company's 60-cycle supply to 25-cycle, single-phase through a frequency changer substation located at Skykomish. In this station there will be two 7,500-kva. General Electric sets, each consisting of an 8,000-kva., 13,200-volt, 3-phase, 60-cycle motor and a 7,500-kva., 13,200-volt, single-phase 25-cycle generator. Each set will also include on the same shaft a 52-kw. exciter for the motor and a 77-kw. exciter for the generator. There will be three single-phase, 2,750 kva., 110,000/13,200-volt transformer units. For the 25-cycle distribution, two 7,500-kva. transformers are used, stepping up from 13,200 to 44,000 volts for the feeder distribution. All of these transformers are of the oil-insulated, self-cooled type.

How to Avoid Accidents With Electric Equipment*

ELECTRICITY eliminates many hazards encountered where steam or other prime movers are used, but if mishandled or improperly installed, it introduces new hazards equally dangerous. The dangerous nature of these hazards can be appreciated to some extent when we remember that electricity is invisible, that it is noiseless, and that it gives no warning of its whereabouts.

The dangers of electricity are from shock, burns, "flashed eyes," and fire. Electrical shock results from the passage of current through any portion of the human body. A shock may produce merely a tingling sensation or a slight contraction of the muscles, or it may produce more severe and painful results. Muscles may actually be injured or the heart action may be stopped. Another common effect of electrical shock is to stop the process of breathing. If breathing is not started again within a few minutes, death may result.

The severity of a shock depends upon several factors. It becomes more severe with an increase in voltage applied; with an increase in area of bodily surface brought into contact with the electrical circuit; or with an increase in the amount of moisture on the contact surfaces. Perspiration on the skin is an example of such moisture. On the other hand, the severity of a shock is decreased as the resistance of that portion of the body in contact with the electrical circuit is increased. For instance, the callouses on the palm of the hand offer more resistance per unit of area than does the wrist of other more tender portions of the body, and while a shock at the wrist might prove fatal, it might perhaps produce only a temporary sensation on the palm of the hand. Another factor of great importance is the course of the current through the body. A current passing from finger to finger of one hand, for instance, has usually only a local effect, whereas when passing from one hand to the other, the course of the current may lie through some vital organ such as the heart or the central nerve system, and it is therefore more likely to cause serious results. A similar serious result might follow when the path of the current is from the neck to the foot, or from a hand to a foot.

Electricity, in its passage through a conductor, develops a certain amount of heat which exerts a drying effect on nearby articles and may even set them on fire. An electrical current, when passing through the body, may be distributed over a wide path where there is enough fluid to prevent immediate drying. At the point of contact, however, the current may be concentrated in a small area, and here the body fluids not being present in great quantity, may be dried up so quickly as to cause a local skin or flesh burn. Burns usually accompany all severe shocks and they often result when the shock is comparatively slight.

Burns may also be caused by contact with a mere proximity to an electrical arc. When a current, in following its path, is compelled to jump an air space, the intervening air, gases, and volatilized particles of the conductors are heated to a state of incandescence and the flame thus produced is known as an electric arc. The heat of an electric arc is the highest temperature obtainable by man. It is always dangerous and every precaution should be taken to prevent its accidental occurrence. An arc may be caused by the effort of a current to flow from one conductor to another, even though there is no direct connection between the two conductors. Arcs may form at points where the insulation has been weakened or broken down or at loose joints or connections in wires. An arc may also be formed when opening a switch. This operation should not be done hesitatingly, but with one strong, rapid motion.

Another serious hazard of electric arcs is that of injury to the eye, i.e., "flashed" or burned eyes. When welding electrically or doing other work near an electric arc, operators should be required to wear protective goggles with properly colored lenses. Unexpected movements of devices such as circuit breakers may cause injury to persons who happen to be near enough to be struck. The unexpected starting of motors may also cause injury to men working on them as well as to men operating machines controlled by these motors.

Electrical equipment, to be safe and to give the best service, must be properly installed. Qualified electricians should be employed to perform all work of installation. Workmen who are not electricians, through ignorance, careless connecting, soldering, taping, or otherwise, may create many unnecessary hazards. Wherever possible it is recommended that all wiring be placed in conduits and that current-carrying parts of equipment be completely enclosed. The conduit can be placed in the most convenient location.

In the event of any electrical appliances becoming defective, inexperienced persons, either workmen or foremen, should not attempt to make repairs. Blindness, burns, or death may be the penalty. Only an electrician should be called to attend to all repair work. Inspections should be made at proper intervals to ascertain that all electrical equipment is in good condition, and any defects immediately repaired.

*Abstracted from the Report on the Reduction of Accidents to Employees presented before the convention of the American Railway Bridge and Building Association at Buffalo, N. Y., on October 22, 1925.

Construction Details of an Armature Press

An Important Machine Used in the Train Lighting Repair Shop of the Southern Pacific at West Oakland

By Niels Hansen
Assistant Foreman Electrician, Southern Pacific Railway, Oakland, Cal.

THE armature press pictured in Figs. 1 and 2 was designed several years ago by the writer with particular reference to its being used on train lighting repair work—armatures in particular. It is now an indispensable piece of shop apparatus and has paid for itself many times over in labor saving and in better quality of work turned out due to the ease and convenience in the way the work can now be handled. Formerly an old makeshift press setting on the floor was used consisting of two 1 in. iron rods about 3 ft. long passing through two cross pieces of iron above 1 in. by 6 in. by 15 in., one having a hole in the center for the armature shafts to pass through. Distance pieces made from short pieces of pipe were put between the armature spider and one of the cross pieces while the other crosspiece pressed against the end of the shaft. The 1 in. nuts on the ends of each rod were then drawn up alternately with an 18 in. monkey wrench and a pipe extension lever on the end of this when necessary, until the shaft was pressed in or out. Needless to say, this old arrangement wasted a great deal of time and exhausted the patience of even the best disposed workmen. It always required at least two men to operate while most of the work on the present press can be handled by one man very quickly.

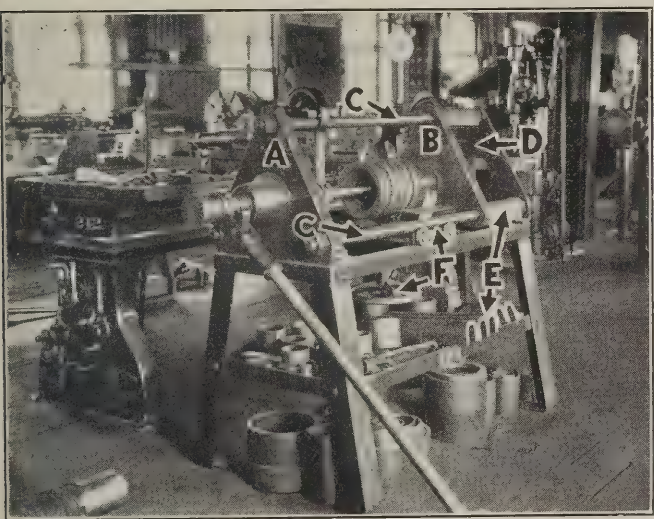


Fig. 1 General View of the Press

The design of our new press was worked out with the following points in view, practicability for train lighting work, adequate power for one man to operate, substantial construction, saving of labor, convenience and appearance. While the pressing in and out of armature shafts of various sizes from the 35 kw. head end General Electric Company turbo-generator armature to the small axle generator armatures is the principal object of the press, still the following operations are also provided for: —pressing on commutators; pressing armature spiders into laminations which are already assembled, from small armatures like the Pyle types E2 and C up to the 100 ampere U. S. L. type C armature; straightening of shafts which have been bent in service or in welding and do not bend where desired by using a bar while in the lathe centers; pressing up or straightening laminations which have become flared out at the ends; holding laminations under pressure while applying the lamination lock rings as used on U. S. L. armatures or locknuts or other types of armatures; pressing in bushings when repairing bale or rocker shoes, generator heads, generator pulleys, etc.; pressing off generator heads and ball bearings where the latter are pressed or frozen on the shaft; pressing off frozen ball bearing hubs or frozen generator pulleys which do not yield to the pulley pullers, etc.

The following are the outstanding features of the press:

1—It is made of substantial construction throughout; the screw plate *A*, Figs. 1 and 2, and the pressure plate *B*, Fig. 1, are forged out of steel and the strain rods *C* are made out of steel motor car axles.

2—It is of sufficient power that a 150-lb. man exerting his weight 3 in. from the end of the lever can cause a pressure of 47 tons on the end of the screw which is enough for practically all ordinary operations encountered. If necessary, this can be greatly increased by using an extension lever of about a three foot piece of 1½ in. pipe over the end of the regular lever.

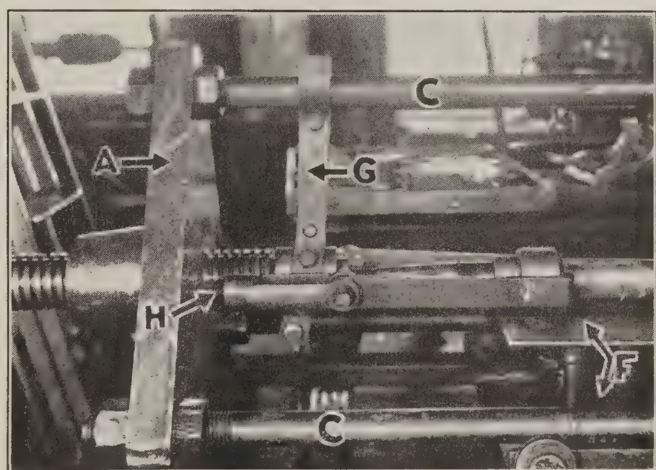


Fig. 2 Enlarged View of the Pressure End

3—The screw and parts are patterned after a screw jack, in fact the handle, ratchet, pawl and cap were taken from a broken ratchet screw jack. This type of press was built in preference to an air press on account of it being more sensitive, in a way that the workmen can feel just what he is doing much better.

4—The head on the pressure end of the screw is made a swivel and case hardened. It is prevented from turning with the screw by means of the clamp *G*, Fig. 2, which terminates into a U-shaped guide fitting up under and on the sides of the top strain rod *C*. This protects the ends

and centers in the shafts from becoming damaged. The face of the swivel head is counterbored to take short bushings of different bores which will fit over the ends of the various size armature shafts thus centralizing them in the press.

5—The triangular shape of the press gives the maximum amount of room to work in, much more than if it was made square. It is much smaller than a square press would be for the same spacing of the strain rods which is 16 in. centers. This spacing permits any of the armatures with generator heads on to be passed through.

6—The pressure plate *B*, Fig. 1, has three equidistant clearance holes through which the strain rods *C* pass and can be shoved to any position desired and kept from moving back by placing one or more sets of U-shaped spacer irons *E*, Fig. 1, over the strain rods *C* between it and the end plate *D*, Fig. 1. The end plate *D* acts only as a spacer for the strain rods and a means of securing the press to its stand. The actual strain is taken up by the double 1½ in. steel nuts on the ends of each rod.

7—A four-wheeled carriage supporting a swivel armature cradle adjustable for height, forms a most useful and convenient part of the press. This cradle can be seen in Fig. 1, supporting a U. S. L. type M armature or a closer up view in Fig. 2. Turning the hand wheel located below the carriage raises or lowers the armature cradle very quickly. The carriage supporting a load can be shoved to the right or left with little effort with the aid of the four wheels which run on the top of the stand used for a track. An extension of one side of the cradle is bent over flat and horizontal extending over and just beyond the lower strain rod forming a small shelf, which is used to rest an armature on for a moment before rolling it into the cradle. These features of the swivel cradle and carriage save a great deal of labor in lifting, turning and handling the armatures.

8—The stand supporting the press is made of rigid angle iron construction 28½ in. high and 49 in. long making the center of the screw 35½ in. above the floor, which is a very convenient height to work at. The legs extend out in front and in back at an angle thus preventing the stand from tipping when using the long lever. It is of sufficient weight not to need fastening to the floor.

9—The legs are braced by means of horizontal pieces of angle iron bolted to the inside of each leg about half way up from the floor and forming a rectangular framework of L-shaped cross-section. This is made into a tray by placing a sheet of ⅛ in. tank steel on the bottom which forms a convenient place to keep the various accessories of the press. The tray is plainly seen in Fig. 1.

10—The screw plate *A*, Fig. 2, has two holes, one on each side of the screw tapped out for 1 in. by 3 in. studs, one of which can be seen at *H*, Fig. 2. These are used as part of a pulling device shown in Fig. 2, on operations where the pressure plate *B*, Fig. 1, cannot be used to advantage, such as pulling off a frozen generator pulley with the head in back of it; pulling off a ball bearing brush rig when the brush rocker hub has become frozen to the shaft of a No. 20680 Safety generator or pulling off the ball bearing and pulley end back grease cap from a 3 kw. Safety high speed generator shaft, etc. The set up shown is fixed for pulling off a frozen No. 20101-B.B. hub from a Safety armature shaft. The two pulling bars have their ends bent at right angles to form a sort of hook in back of the hub. A clamp (not shown) is then used over the two bars to prevent them slipping off when the pressure on the screw is applied. Different bars or bolts are used for different jobs, but all fit into the clevises through which passes a ¾ in. pin to hold them. The clevises have tapped heads which screw on to the 1 in. studs.

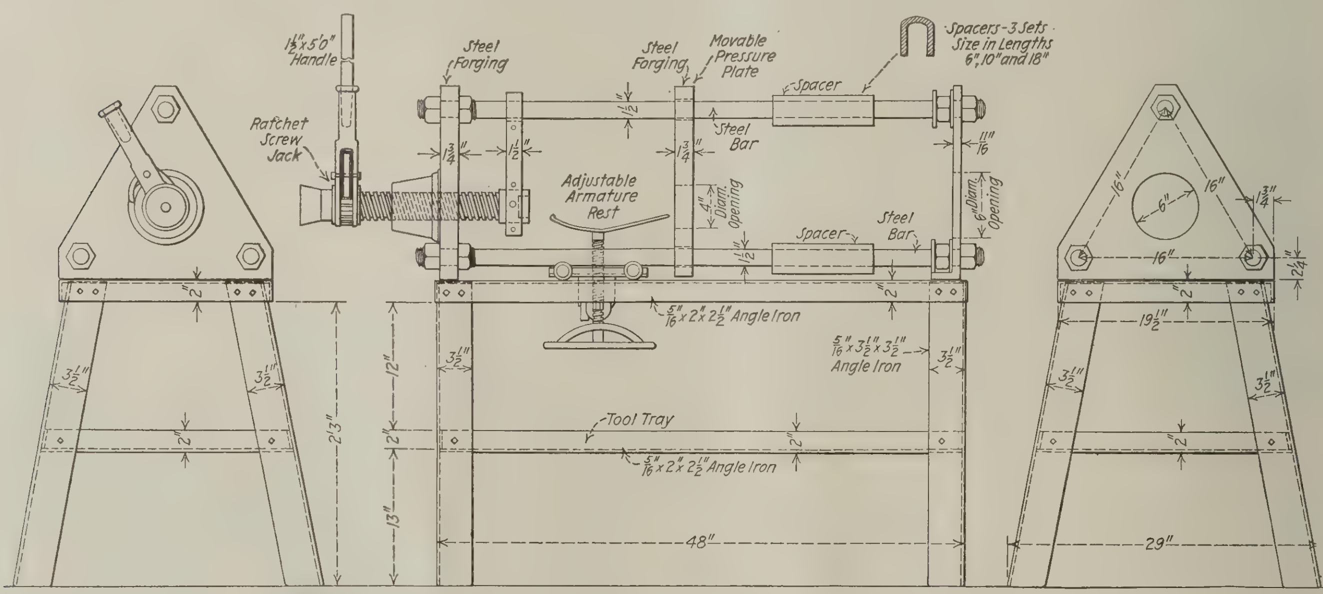


Fig. 3 Drawings Showing Dimensions and General Arrangement of Parts of the Armature Press

The power screw is 2¾ in. diameter and 19½ in. long overall, 14 in. of which is square threads of ½ in. pitch or 2 per inch. The left hand end is turned down to 2 5/16 in. diameter for a distance of 4⅛ in. The handle, ratchet, and washers take up 2⅜ in. of this amount leaving 1¾ in. on the end for the cap. Three equidistant projecting dowel pins in the cap engage in a square groove 5/16 in. wide by 3/16 in. deep cut in the screw 1 in. from the end allowing the cap to turn. The right hand end of the screw is turned down to 2 in. diameter for a distance of 1¼ in. from the end and forms the seat for the pressure head which also has three projecting dowel pins which engage in a square groove 5/16 in. wide by 3/16 in. deep cut in the screw 7/17 in. from the end. This pressure head is 3 in. diameter and 3 in. long countererbored 2 1/64 in. diameter on each end and 1 3/16 in. deep. The

end of the screw is case hardened and likewise the inside part of the pressure head against which the screw turns. The steel ratchet is pressed and keyed on the opposite end of the screw inside the handle. It is 3⅞ in. diameter, 1 1/16 in. wide and has 13 notches for the steel pawl to engage in. The cast iron cap is 3⅛ in. long and 3¾ in. diameter at the outer end tapering down to 3⅛ in. at the other end which is counterbored 2 21/64 in. diameter, 1¾ in. deep. The handle is malleable iron measuring 10¾ in. long from the center of the screw and has a tapered socket for a lever. The lever used is a piece of 1½ in. by ¾ in. steel tubing 45 in. long, one end being tapered to fit the handle socket.

The screw plate *A* is a triangular shaped steel forging planed 1¾ in. thick and having a hub in the center extending out 4½ in. which tapers from 6 in. to 4½ in. in diameter at the end. This makes a thickness of 6¼ in. for the screw threads. The three holes through which the strain rods *C* pass are 1 9/16 in. diameter and spaced equidistant, 16 centers. The three sides are all parallel to the centerlines through these holes, the bottom being 2½ in. below and the other two sides 1¾ in. out from the centerlines. The top corner is rounded off to a 1¾ in. radius. The bottom, which is 20 in. long, has its ends squared to allow for the carriage *F* to run under the strain rods *C* and also to allow the pressure plate *B* to slide freely.

The pressure plate *B* is likewise a steel forging, triangular shaped and planed to a thickness of 1¾ in. It is an equilateral triangle of the same general dimensions as the screw plate *A*, except the base. The three corners are rounded to a 1¾ in. radius. The three equidistant holes through which the strain rods *C* pass are drilled 1⅝ in. to allow the plate to be easily pushed to the left or right. A 4 in. diameter hole is bored through the center to permit the armature shafts to pass through.

The strain rods *C* are 52½ in. long overall and 1½ in. diameter and were made out of second hand hand-car axles. The 1½ in. hexagon steel nuts on the end of each rod take all the strain and also clamp the screw plate and end plate *D* at the proper spacing.

The end plate *D* is made of ⅝ in. tank steel and is of the same dimensions and shape as the screwplate *A* with the exception that the bottom is long enough to be bent over 2 in. at right angles to provide a means of securely bolting it to the base. The hole through the center is 6 in. diameter and permits extra long shafts to project through such as the 25 kw. turbo-generator shafts and also enables the workman to look through it to see if his work is properly set up and centralized.

The carriage *F* consists of a piece of ⅜ in. tank steel 9 in. wide by 17½ in. long including the two ends which are bent up at right angles a distance of 1¼ in. Two 2½ in. diameter wheels, ½ in. thick with a 1 in. bore are fastened to each end of this carriage, by special 1 in. shouldered pins threaded on the inside with a ⅝ in.—11 thread. These are drawn up tight on the inside of the carriage by ⅝ in. nuts. The length of the wheel bearing allows 1/64 in. lateral play of the wheels. The top of the stand or base of the press form the track or runway for the carriage. Two ⅜ in. guide pins extend through the bottom of the carriage on each side below the top of the stand and just clear the inside edges of it. The screw head of an old paper press is bolted to the bottom side of the carriage with the screw extending up vertically through a hole in the center. This screw, which can be plainly seen in Fig. 2, is 1¼ in. diameter and has square threads of 1/3 in. pitch (three threads per inch) cut on it. An 11 in. diameter handwheel is keyed and secured by a nut on the lower end of the screw. The top end of the screw is 1¼ in. diameter without threads cut in it for a distance of 1¼ in. A socket fits over the end made from a steel forging somewhat resembling the letter T in shape with the top made concave. The vertical part of the T is turned to 2 in. diameter 1½ in. long and counterbored 1 17/64 in. diameter, 1⅛ in. deep and square at the bottom so as to turn easily on the end of the screw. The top part of the T is about 2½ in. by 5 in. looking down on the top and ¼ in. in the center. The angle between the two top sides is about 135 degrees. The armature cradle is screwed onto the top of this socket with flat head screws. It is made of 3/16 in. tank steel 9 in. wide and 1½ in. deep and curved to fit a 10 in. diameter armature although the center is V-shaped corresponding to the angle of the support thus centralizing any size armature. The extension of one side forming a rest as previously explained is 4½ in. by 9 in. the outer edge extending 9 in. from the center. The cradle and its supporting socket can be turned around on the end of the screw if desired or removed as a unit by just lifting it off. The range of travel vertically is 3 in.

The top of the stand to which the press is bolted is a rectangular frame 20 in. wide by 49 in. long made out of 1 piece of 5/16 in. by 2 in. by 2½ in. angle iron with the corners V'd out and welded into a solid frame. The 2½ in. side of the angle iron forms the top. The form legs are made from 5/16 in. by 3½ in. angle iron and are riveted to the inside corners of the top frame. The legs extend out in front and in back at an angle making the width at the bottom of the stand 9 in. greater than at the top. The front side of the front legs and the back side of the back legs are turned under at the bottom 4 in. forming four feet laying flat on the floor each having a 13/16 in. hole in the center so that the stand may be bolted or lagged to the floor if desired. These feet can be seen in Fig. 1. The iron tray already spoken of is made from four pieces of 5/16 in. by 2¼ in. by 2¼ in. angle iron bolted to the four legs and forming the sides and supports for the bottom of the tray which is a sheet of ⅛ in. tank steel 24 in. by 48 in. The bottom of the tray is 13 in. above the floor.

The three sets of spacers E, Fig. 1, are made from ⅝ in. tank steel bent U-shape, 1 9/16 in. wide by 2½ in. deep inside. They are bent to a radius conforming to the strain rods *C* over which they are placed. The ends are planed off square. Three lengths 6 in.—10 in.—and 18 in. were selected, one for each set of three. These give all the spacing adjustments necessary. By using them singly or in combination the pressure plate *B* can be moved to the left from the extreme right hand position against the nuts on the strain rods *C*, the following distances, 6 in.—10 in.—16 in.—18 in.—24 in.—28 in. and 34 in.

The various short bars, pieces of steel tubing and pipe seen are the tray and under it in Fig. 1 have been cut from time to time to handle the numerous jobs that are done on the press.

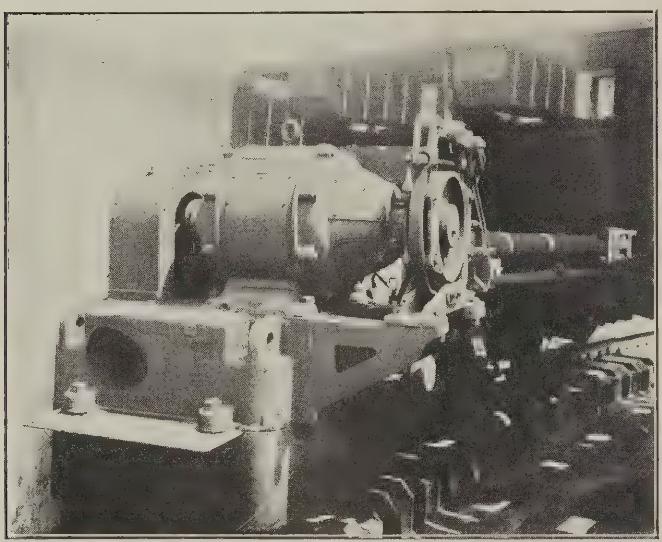
Fig. 3 is taken from a blueprint of a rough drawing of the press showing the front and both end views. It is not drawn to any scale. The dimensions shown were only measured roughly. It will, however, aid in visualizing the descriptions given above.

Types of Motors Used in Railroad Shops*

A Discussion of the Application and Maintenance of Both Alternating and Direct Current Equipment

BROADLY speaking, motors are divided into two classes, alternating current and direct current. The former may be of the induction type, squirrel cage or wound rotor or of the synchronous type. Direct current motors are series, shunt or compound wound.

A suitable motor is available for each application and in order for the proper motors to be applied to shop equipment it is only necessary for the engineer in charge to be familiar with the characteristics of the various motors in



Turntable Tractor and Motor With Separately Mounted Magnetic Brake

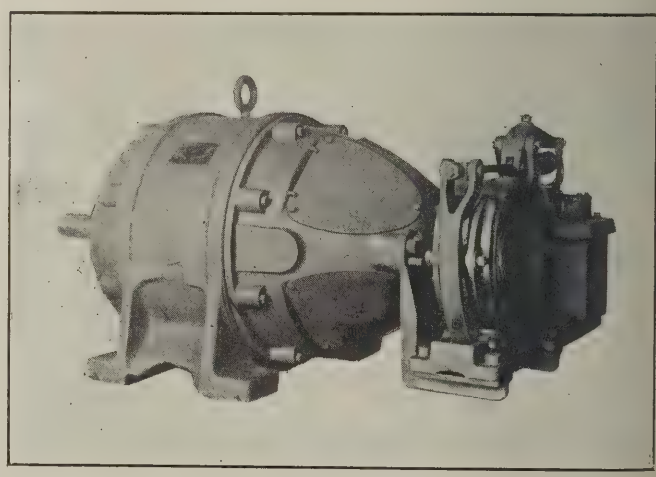
order to intelligently prepare specifications. The ideal shop layout will provide both alternating and direct current.

Turntable Application

From the view point of smooth functioning of locomotive terminals it seems to be generally conceded that turntables are the most important single pieces of equipment. Present indications are that turntables are going through a period of transition, from lengths of from 75 to 90 feet to lengths of 100 or 110 feet, to meet the demands of the larger locomotives. In many instances the new tables are being provided with two motor drive, that is, a tractor and motor at each end of the table. When this scheme is employed it is good practice to provide motors of horse power sufficient for either one of them to temporarily handle the table in the event of the other tractor being out of commission. This can be appreciated, especially by the engine house foreman whose predicament, with a broken down turntable, the transportation people calling for power and the master mechanic practically holding a stop watch on him, is not enviable.

Opinion is not unanimous concerning the rating of the motors for turntable drive. When only alternating current is available, wound rotor motors should be used because the starting characteristics both regards to current demand and torque are superior to squirrel cage motors. One large turntable manufacturer recommends two 25-horsepower motors with a 55 degree C. 15 minute rating and a leading eastern railroad specifies two 35 hp. motors with a 55 degree C twenty minute rating. On both specifications the motors are totally enclosed and have twelve poles. When direct current is available the turntable manufacturer specifies 2 series wound motors having a rating of 25 hp. for fifteen minutes and the railroad company specifies series motors having a rating of 35 hp. for 15 minutes. A difference of opinion also exists with regard to the resistors to be used with the motors. Some specify Electric Power Club Classification 53 which calls for light intermittent duty, one minute out of four and others specify class 73 resistor, heavy intermittent duty, two minutes out of four. It is interesting to note that both of these resistors are designed so as to provide approximately 70 per cent of full load motor current on first point of controller. Resistors should be of either the alloy grid or edge wound type to assure "standing up" in this class of service which, next to crane service, we believe, is the most severe service to be met in railroad shop applications.

The control for two motor turntable drive presents an



Turntable Motor With Self Mounted Brake

interesting study. Three schemes, to our knowledge, are specified by users and manufacturers. The first and simplest utilize a duplex drum controller for handling, in a.c. installations, the stator and rotor currents and in d.c. installations the armature and field current. Overload and low voltage protection are obtained by means of a manually operated circuit breaker, with an under voltage trip attachment, located in the main feed.

The second scheme provides a main line contactor, with an electrical interlock, automatically closed in the "off" position of the controller. Overload protection is obtained by means of two overload relays, one in each motor circuit, arranged so that when an overload occurs the action of the relays opens the circuit of the holding coil of the contactor, allowing the contactor to drop out. If the line

*Abstract of a paper presented before the Southern & Southwestern Railway Club by Charles F. King, Jr., general engineer Westinghouse Electric & Manufacturing Co.

voltage fails, the whole control circuit will, of course, be deenergized and the line contactor will drop out. As this contactor can be reset only in the off position of the controller, low voltage protection is obtained.

The third arrangement of control, applicable to alternating current motors only, provides for only the rotor currents being handled through the controller. The stator currents are handled through two main feed contactors, one for forward operation and one for reverse operation, one of which is automatically closed from the first point of the controller in forward position and the other is closed from the first point of the controller in reverse position. Overload protection is obtained by two overload relays, one in each motor circuit so arranged that when an overload occurs the action of the relays opens the circuit of the holding coil of the low voltage relay; the low voltage relay

One Hundred Ton D. C. Motor Operated Crane in Locomotive Erecting Shop

contacts open and as they are in series with the holding coils of the main contactors the holding coils are deenergized which permits the contactor, forward or reverse, to drop out. Low voltage protection is provided, except on the first point of the controller.

Magnetic brakes are specified by some users and others maintain that foot brakes are the proper decelerators. With magnetic brakes it is impossible for the turntable operator to "plug" the motors before obtaining at least some braking effect. Also it is impossible for the brakes to be applied with power on. Magnetic braking removes the human element from one operation in the daily routine of receiving and dispatching locomotives, for which it is worthy of serious consideration. Experience has shown that, in the long run, considerable less maintenance is required on motors and tractors when magnetic brakes are used and it would appear that the comparative small additional cost of installing them is justified.

The Reason for a Wound Rotor

Automatic coal wharves, usually of reinforced concrete construction, are displacing the inclined track type wharves, of wood construction, which are natural fire hazards. Constant speed motors are used for these applications. In a. c. application, when the reversal in direction of travel of the buckets is obtained by reversing the motors, wound rotor motors are used because they have to start the buckets up under full load and, as stated in our discussion of turntables, these motors, with slip rings and with external resistors in the rotor circuits, have the necessary starting torques with reasonable current demands. In order to start under full load with a squirrel cage motor the motor has to be thrown directly on the line because starting at reduced voltage, as with an auto transformer or resistance type starter on, say, 60 per cent of line voltage, reduces the starting torque in proportion to the square of the voltage. With 60 per cent voltage at start the torque will be 36 per cent of the torque available when starting under line voltage. On the other hand the reduction in current demand will be, approximately, in direct proportion to the reduction in voltage or 60 per cent of the current demand under full voltage starting. To take a concrete example: A ½ hour, 50 degree C, 6 pole, 25 hp. squirrel cage motor, with high resistance rotor, such as is used in elevator service, will, when thrown directly across 220 volts, 3 phase, 60 cycles, demand 240 amperes. The possible starting torque under this condition is 350 ft. pounds. The full load, or 25 hp. torque is 135 ft. pounds. The full load, or 25 hp., current demand of the motor is 75 amperes. There is no question but what the motor will handle the load but a current demand of 240 amperes is too great for this application. We, therefore, consider reducing the starting voltage to 60 per cent of line voltage, or 132 volts, and we find that the motor will exert only 126 ft. pounds torque which is less than the 25 hp. torque rating. The current has been reduced to approximately 144 amperes, which is still high, in addition to which we find the motor will not exert sufficient torque to start the load so we give up the squirrel cage motor and investigate the wound rotor motor. We find that we can start a motor of this type with full line voltage applied to the stator, obtain full load torque and accelerate up to full load speed and at no time demand more than approximately 125 per cent of full load current which in this particular instance will be in the neighborhood of 81 amperes.

The control will be arranged for push button starting and stopping with full automatic control with current limit acceleration during the working period. If, as is sometimes the case, the reversals in direction of travel of the bucket are obtained mechanically, a reversing motor is not required. This application is met with a squirrel cage motor and an auto-transformer or resistance type starter either manually or semiautomatically operated. If direct current is to be used a shunt wound motor which has practically constant speed characteristics will be applied.

Motors on Cranes

Modern locomotive terminals are usually equipped with motor operated cranes with clam shell buckets to clean the ash pits in lieu of air hoists or locomotive cranes, sometimes called "Cherry Pickers," both of which have been popular in the past. Locomotive cranes still come in very handy when serious breakdowns occur to the overhead traveling cranes or gantry cranes. At one terminal, where approximately 185 locomotives are handled per day, the general foreman has been known to speak almost affectionately of the "Cherry Picker" in times of emergency. Either the gantry crane or the overhead traveling crane will require three motors to operate it—one for the travel lengthwise of the ash pits, one for the trolley and one for the hoist. The motors will, in alternating current installations, be of the wound rotor type and in d. c. installation they

will be compound wound. The control will be manually operated drums to handle both the stator and rotor currents in a. c. applications and the armature and field currents in d. c. applications. Magnetic brakes are used in conjunction with the trolley motor and the hoist motor and a foot brake is used with the bridge motor. Motors for this class of service and for all other classes of crane service are designed with rugged mechanical parts, large shafts, and bearings to withstand the wear and tear of overhung pinions in reversing service; high starting torque; ample overload capacity; high continuous rating; small diameter armatures thus reducing the power required to accelerate and stop the motors themselves; armatures well banded to stand the high rotating speeds that are occasionally encountered in d. c. applications. Accessibility for ready inspection and maintenance of wearing parts is, of course, essential. Protection from the weather is secured by means of double impregnated moisture resisting insulation and totally enclosing covers.

Ash pit crane service will be satisfactorily met with resistors having Electric Power Club classification 53 for the bridge motor and class 73 for the trolley and hoist.

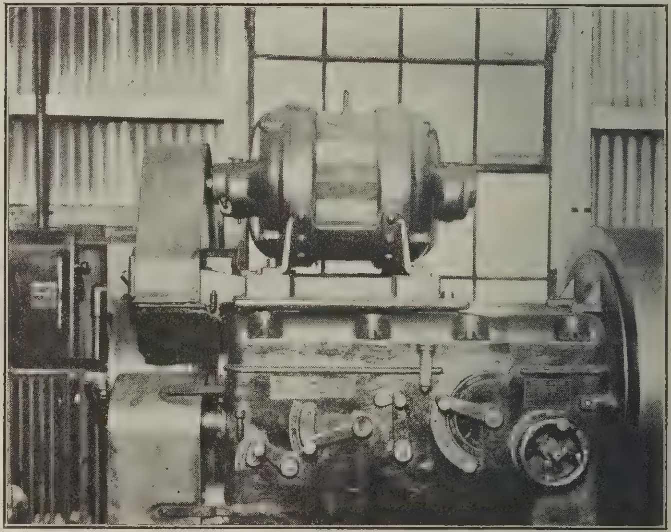
The control equipment for cranes such as are used in machine shops and erecting shops is divided into two classes: Manual, that is, opening and closing the motor circuits by drum controller; and magnetic, which handles the circuits through magnetic contactors actuated by master switches. Manual control is used on general purpose cranes when the motor ratings are below 50 hp. By general purpose cranes we mean cranes, the operation of which is at irregular intervals with loads that vary over a considerable range. With ratings above 50 h. p. magnetic control is used. Magnetic control is not only better adapted to handle heavy currents but because of its automatic features it also gives better protection to the crane and motors. In direct current applications, the hoist controller generally provides dynamic braking when lowering a load and also allows a light load or empty hook to be accelerated downward. On alternating current cranes, this result is accomplished by means of a mechanical device known as a "load" brake.

Why D. C. Motors Are Sometimes Desirable

The advantages that direct current motors possess over a. c. motors, in crane service, with regard to flexibility of performance brought about by their capacity to exert very large starting torques and the dynamic braking that is possible with them, have been influential in their adoption by most railroads where general purpose crane service is required. The a. c. motor has a definite maximum starting torque and pull out torque which cannot be exceeded. The maximum starting torque will range from 2.25 to 2.50 times full load torque and the pull out torques will range from 2.4 to 2.8 times full load torque. A d. c. series or compound wound motor with interpoles will exert a starting torque of more than 3.5 times full load torque, full load torque being taken as the torque corresponding to the ½ hour, 75 degree C, or crane rating of the motor. This value of starting torque, however, is not a true measure of the ability of the motor to do work. It is merely a factor for convenience in estimating on applications. As a matter of fact, the d. c. motor will try to pull as long as current flows to it and the more current that flows the more it will pull until, finally, it will burn up if not relieved of the load. The characteristic ability of the d. c. motor to handle heavy overloads often makes it possible, in general purpose crane applications, to use d. c. motors of smaller horsepower ratings than good engineering practice would dictate for a.c. applications. Circuit breakers, fuses or overload relays prevent the motors from becoming overheated when the crane operators are unaware they are handling dangerous overloads.

Drop tables for unwheeling locomotives present application requiring high starting torques and as such call for wound rotor a. c. motors or series wound d. c. motors. One leading railroad uses the identical motors for drop tables that it uses for turntables. Thus the parts of the motors are interchangeable which reduces the number of renewal parts necessary to keep on hand. Drum controllers and class 53 resistors will be found satisfactory.

The advantages of individual motor driven machine tools over machine tools driven through line shafting, pulleys and belts are generally recognized. The sum of the horsepowers of the motors, providing individual drive for a given group of machine tools, will be, perhaps, 50 per cent greater than the horsepower of a single motor that could be used to group drive the same machines. This



Squirrel Cage Induction Motor Driving Engine Lathe

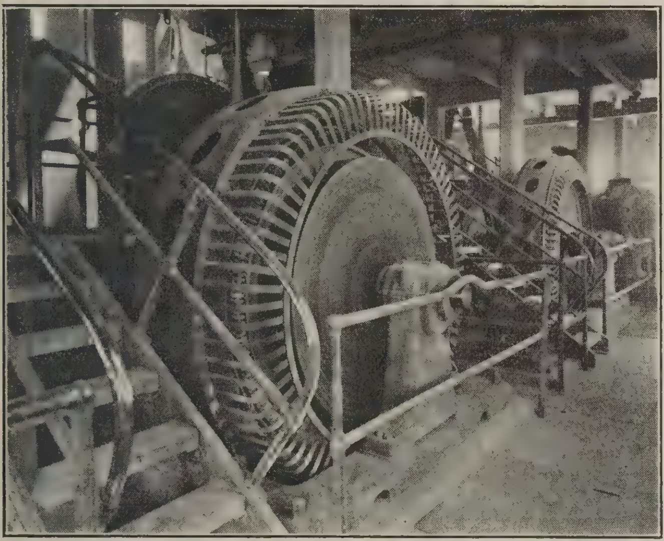
is brought about by the fact that each individual motor must be able to handle the full load on the machine where as in the group drive it is reasonable to assume that at no time will all the machines, making up the group, be operating simultaneously at full load. It would appear conservative to estimate, that, in most railroad shops the maximum demand from a given group of machine tools will, at no time, not exceed 75 per cent of the maximum demands of the individual machines making up the group, Evidently, then, the first cost of the group driven machines, including line shafting, pulleys and belts will be less than the cost of the same machines with individual motors. When we have said the foregoing, we have said all in favor of group drive. Operating and maintenance costs, the degree of flexibility possible in locating the machines, the illumination of the shop which it is possible to obtain and the handling of material by means of cranes are all in favor of the individual motor driven equipment. These, together with the improvement in morale of the employees, which is a natural outcome of better working conditions, more than balance the greater initial investment.

We stated near the beginning of this paper that the ideal

shop will have provision made for a supply of both a. c. and d. c. The basic current will be alternating because its voltage can be stepped up or down, for transmission or distribution, through high efficiency transformers. Direct current is usually obtained by means of motor-generator sets or synchronous converters.

Direct current may be used for all machine tool drives, but on some machines it has little or no advantage over a. c. drive. When close speed adjustment is desirable and on reversing machines direct current is preferable. When alternating current motors are used the general practice is to use those of the constant speed or squirrel cage type and speed adjustments are obtained by gear shifting. Where the nature of the work does not require frequent speed changes this arrangement furnishes satisfactory drive.

With direct current motors it is possible to obtain dynamic braking at a small increase in cost of control. This permits very quick stops and in some instances will provide an increase in production when frequent stops are required. Direct current motors are used, practically without exception, in the plants of the Ford Motor Company. On reversing drives the usual practice is to provide dynamic braking, with consequent quick and smooth reversals and minimum strain on the machine parts.



View of 350 Hp., 80 Per Cent P. F., 180 R. P. M. Clutch Type Synchronous Motor

One of the main reasons for the success of electric drive of machine tools is the ease with which various functions may be accomplished electrically that would be impossible or difficult with mechanical drive. Protective features, automatic functioning of motors, and interlocking of two or more motors can be accomplished more easily with electric drive.

Applying A. C. Motors to Machine Tools

Obviously, in all machine tool applications, where it is at all possible to do so and we believe it is possible in 90 per cent of the machine tool applications in railroad shops, a. c. squirrel cage motors should be used. The first cost is less than the first cost of d. c. motors and the simplicity of construction, the only wearing parts being the bearings, makes for low maintenance costs. Now that it is possible to obtain sleeve bearings that will keep the oil in and dirt out, maintenance expense of squirrel cage motors need give very little concern. Bearings wear down because minute particles of abrasive matter enter the housings and displace particles of the oil filament between the bearings and the shaft. If it is possible for dirt to enter it is possible for oil to get out, the result being that the windings are finally soaked with oil and dirt. Consequently the life of the insulation is very much reduced. A bearing housing, that keeps the oil in and dirt out, embodied in a squirrel cage motor of high class construction will make of that motor a motive unit the maintenance cost of which will be surprisingly low. Motors of this construction have been in service for eighteen months, practically twenty four hours a day, and no oil has been added. The windings are described as "bone dry."

Use of Synchronous Motors

Synchronous motors are used in railroad shop application to drive air compressors and as the motor ends of motor generator sets, the generator ends being either direct current or alternating current. When the generator end is alternating current the motor generator set is called a frequency changer because the frequency of the output is different from the input. Frequency changers are sometimes used to obtain 25 cycle current for electric traction and now that automatic train control and automatic train stop, both of which, in some installations, utilize 100 cycle or 140 cycle current for the track circuits, are being installed to comply with the orders of the Interstate Commerce Commission, a new field, in the railroad world, has developed for synchronous frequency changes. The synchronous motor is preferable to the induction motor because its power factor can be controlled. In shops, where the principal load consists of induction motors, the system power factor will usually be relatively low. A synchronous motor driving an air compressor or an electric generator provides a convenient means for improving the system power factor.

Applications of standard synchronous motors are limited to those requiring low starting torque. This condition is met, in air compressor drive, by providing mechanical unloaders which usually function to hold the air intake valves open until the motor is up to synchronoous speed and its field excited.

A new motor, known as the clutch type synchronous motor, which has high starting torque, low starting current and the usual good efficiency and power factor characteristics of an ordinary synchronous motor, has recently been developed.

As a rule we do not appreciate the excellent service and long life obtained from electric motors. Assuming that the motor is in good condition, as it should be if made by a reliable manufacturer, failures are nearly always due to surrounding conditions, rather than to inherent defects. The principal causes of failure are moisture, dirt, and vibration. Failure due to moisture and by moisture we mean not only exposure to weather or drippings from water pipes, but also sweating in a saturated atmosphere or even damp air, which does not cause precipitation on the motor parts but may nevertheless affect the insulation, have to a large degree been eliminated by the application of varnish, by varnishing methods and by proper mechanical support.

Continued vibration will cause the toughest steel to give way in time. Copper and insulation should not be expected to stand up any better.

Dirt, however, is the great enemy of electrical equipment. It clogs up ventilating ducts causing increases in temperature. Such increases, not being due to overload currents and therefore the circuit breakers or fuses will be of no avail to protect against, may finally break down the insulation because, as is well known, the temperature the insulation will stand is the limiting element in the rating of electrical machinery. If of a conducting nature, the dirt may permeate through the insulation or from conducting paths around the insulation, ultimately causing breakdowns. If of an acid nature, or if it contains sulphur or other substance which may react with water to form an acid, break down is almost inevitable.

Summary

In closing we would offer a few suggestions in the nature of a summary.

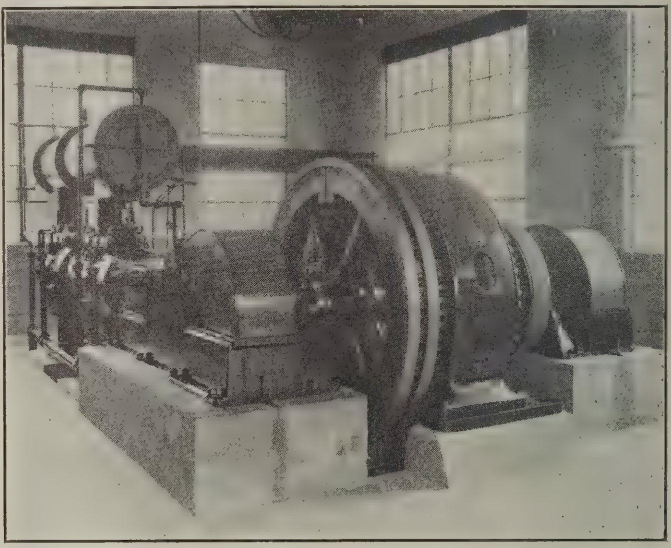
1. Be sure to specify motors and control having characteristics best adaptable to the load to be handled.

2. Bearings that will retain the lubricant and exclude foreign matter are essential for continuity of service.

3. Connect the motors to the loads so as to preclude vibration. Mount pulleys and gears as close to the bearing housings as possible otherwise they may set up high bending stresses and cause shaft deflections.

4. Make sure that overload protective devices serve the purposes for which they are installed. Overheating the motors too frequently will destroy the insulation.

5. Keep the equipment clean; the frequency of cleaning being governed by the location. Obviously, a motor driving a blower in a forge shop will require more frequent cleaning than a motor driving a lathe in a machine shop.



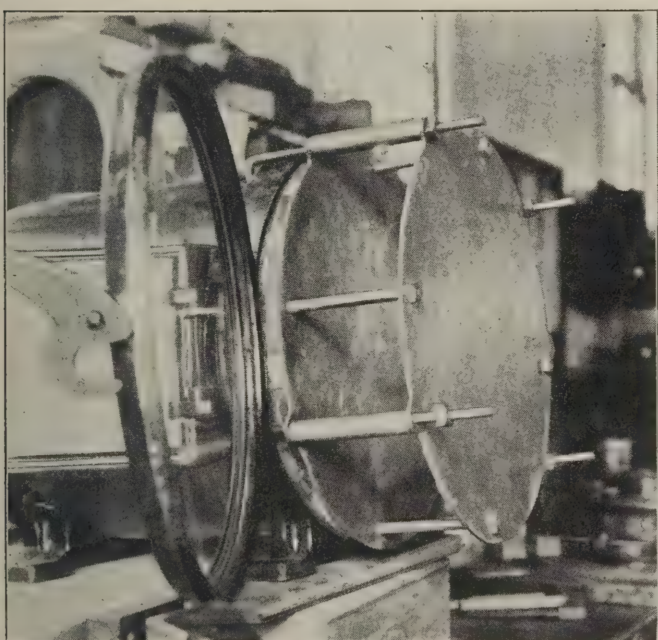
Synchronous Motor Driving Air Compressor

Bellinzona Station, Switzerland

Focusing Headlights in the Daytime

At St. Augustine on the Florida East Coast, the device shown in the illustration is used for focusing headlights in the daytime. The principal which is made use of is that the light beams coming from the headlight reflector travel in parallel lines when the lamp is correctly focused.

The arrangement consists of two circular steel plates supported from an old frame of a headlight door. The plates are separated from each other by four pieces of



Device Attached to Headlight Case Which Will Allow the Lamp to be Focused in the Daytime

conduit, each piece being exactly the same length so that when the two plates are secured together they will lie in parallel planes. The space between the plates is 8 inches although, this may be more or less.

In order that the two plates may be exactly alike, they were both drilled at the same time. In addition to the holes required for passing the hook bolts through to secure the plates to the headlight case, there is a series of 9 very small holes drilled in each plate, these are spaced equi-distant from each other, around a circle whose diameter is 10 inches. In focusing the headlights, the beams of light passing through the small holes in the plate nearest to the light source will register upon the holes in the second or outer plate. This registration will take place, however, only when the lamp is in focus. In all other positions of the lamp, the spots of light on the second plate which are observed on the inner side of the plate will not coincide with the holes and hence it is an easy matter to tell when the lamp is properly focused.

Further adjustment such as the position of the beam upon the track can only be made at night, but this is, of course, quite distinct from the matter of focusing of the light rays.

Various modifications of the headlight focusing device are being constructed by different roads by those interested in this work, but it is understood that the basic patents are held by the Pyle National Company and equipment for daytime headlight focusing may be purchased from this company.

Electric Watchman for Chain Grates

The power plant engineer in the plant of a western railroad has developed a device which automatically rings an alarm when it is necessary to replace grate bars in a chain grate.

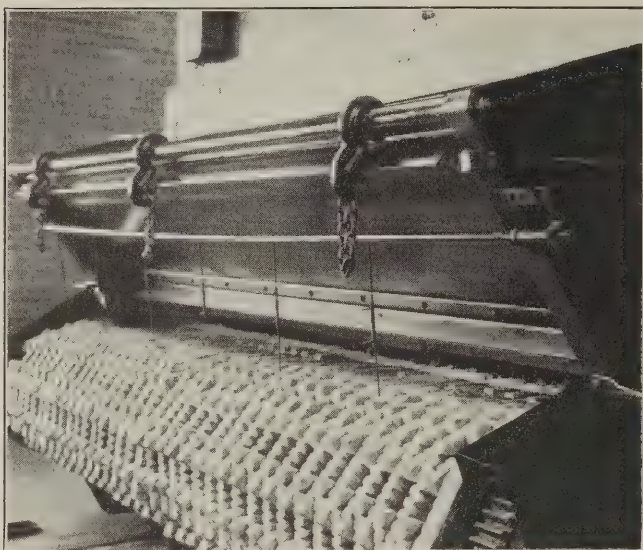
The outer end of the grate and the coal hopper are shown in the illustration. The grate is in effect a link belt which travels on two sprocket wheels or rollers, one roller being outside in front of the furnace and the other at the rear of the fire box or combustion chamber. As the top of the grate moves into the furnace it carries with it coal from the hopper. The coal is burned on the grate and the ashes fall off the inner end of the grate.

In time certain grate bars are warped by the effect of the heat and it becomes necessary to replace them. This can be done while the grate is in service as it moves very slowly. Warping or other deformation of the grate bars causes them to fit the sprockets improperly and the damaged part of the grate will begin to ride up on the ends of the sprocket teeth.

To assist the firemen in watching the grates, the engineer has installed a device which automatically detects deformed grate bars. A piece of ¾ in. pipe is mounted on the front of the hopper as shown by means of two U bolts. The bolts are not pulled up tight but serve as bearings in which the pipe can turn. The pipe is drilled in six places equal distances apart and fitted with six ¼-in. rods which hang down vertically within an inch of the grate bars. Each one of the ¼-in. rods is made in two sections and is fitted together at the center by a sleeve

and two set screws so that the length of the rod is adjustable.

A split fiber block is bolted to one end of the ¾-in pipe and a contact arm about 6 in. long is screwed to the fiber block. Another insulated contact is mounted on the edge of the coal hopper so that it will engage with the contact on the pipe when the pipe is turned. An alarm bell and a bell ringing transformer are connected in



A High Bar on the Grate Causes a Bell to Ring

circuit so that the bell will ring when the two contacts engage.

When a grate bar is warped so that it engages improperly with the sprocket, that part of the grate is lifted up. As the raised section of the grate passes one of the ¼-in. feeler rods it touches the rod. This turns the pipe and causes the bell to ring, thus notifying the fireman that a new grate bar is needed.

Human Nature

There's a thing called *Human Nature,*
Which we acquire at birth
And we take what "Nature" hands us
Regardless of its worth;
We can never swap nor change it
For some other envied brand
Though it oft antagonizes
Those who do not understand:
We may grow a thin Veneering
And certain faults subdue
But underneath the surface
We still are *me* and *you.*
There's a further readjustment
Which mankind can attain
And it helps a lot while living
For it makes us more humane:
Its the art of over looking
Irritating things when met
Or forgetting quite serenely—
The things we should forget:
A man with this attainment
Has an asset here on earth
But we have to go and earn it
To appreciate its worth.

Trying

I love the man who says, "I CAN";
Though *tough* and *hard* the grade;
Who goes right in and—WORKS TO WIN
Until the goal is made!

Though tough the climb, and long the time
Before he'll win the prize;
He neither waits nor hesitates;
But goes ahead and—TRIES!

The staller stands with idle hands,
And cries, *"It can't be done!"*
But this brave heart—*just makes a start*
And soon—THE GOAL IS WON!

Long live the man who says, "I CAN";
Without complaint or sighing!
For work BEGUN—is work HALF DONE!
The hardest part is—TRYING!

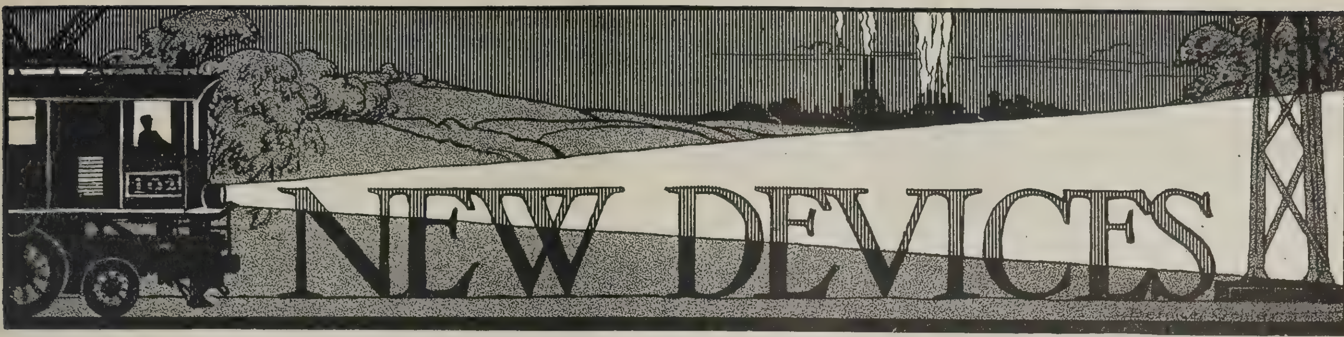
"Our Troubles"

Getting out this magazine is no picnic
If we print jokes, people say we are silly;
If we don't, they say we are too serious.
If we clip things from other magazines
We are too lazy to write them ourselves;
If we don't we are stuck on our own stuff.
If we stick close to the job all day
We ought to be out hustling up news;
If we do get out and try to hustle,
We ought to be on the job in the office.
If we don't print contributions
We don't appreciate true genius;
And if we do print them
The magazine is filled with junk.
Now like as not some guy will say
We swiped this from some other magazine. We did.

This Will Interest You

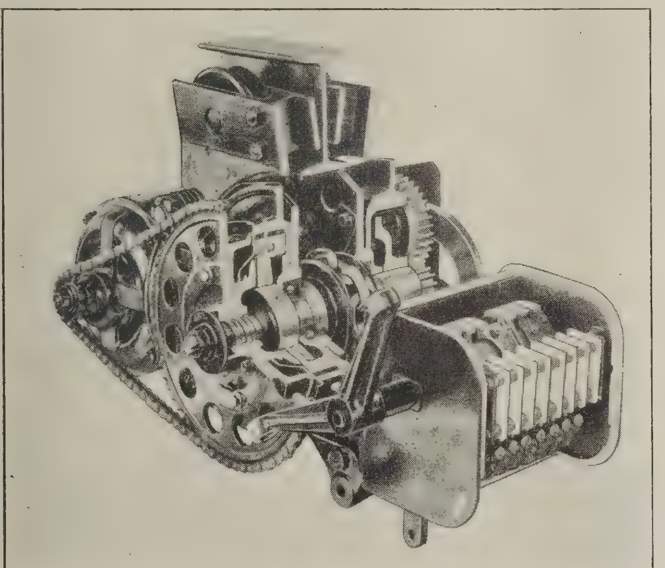
You don't have to be a remarkably fine writer, or an artist to contribute a description of some practical shop-made device or some practice that you have found useful in your daily work. A simple description and a penciled sketch will be fine and we will pay you well for your trouble. If you know how to use a camera, so much the better, as photographs of practical devices are always useful.

This is your particular section of the paper and we are extremely desirous of getting more descriptions of things which men have found useful into it. No matter if you think your device is so simple that everybody knows about it, you may be wrong, and you cannot make money any easier than sending a short write-up of it to the *Railway Electrical Engineer,* addressed to the Interchange Department. You probably have thought you would write something for this department some time but have put it off for one reason or another. Don't wait any longer—do it today.



Ball Bearing Electric Chain Hoist

The Yale & Towne Manufacturing Company, Stamford, Conn., has recently developed a ball bearing electric chain hoist known as Model 20B. It embodies such features as close headroom, long lift, higher speed, automatic top and bottom limit stops, and greater over-all strength. This hoist has high factors of safety in the strength of the load-supporting members and is designed to withstand shock loads so common to this class of equipment. All suspension members of the hoist are made of steel. The hoist can be quickly adapted to any overhead system. The side plates of the trolley carriage can be spaced on steel bars to fit the desired beam flange.



Yale Ball Bearing Electric Chain Hoist with Low Headroom

Yale electrically welded steel chain can be furnished for varying lengths of lift. The centralized steel suspension provides a constantly balanced load on the trolley wheels and hoisting unit irrespective of load position.

The mechanism is fully enclosed in oil-tight chambers and is compact and easily accessible for inspection without expert service. The large chrome vanadium steel ball bearings surrounding the steel load sheave adds a big factor for low current consumption and general all-around hoisting efficiency. The heavy steel one-piece load sheave, ground on an arbor to give perfect concentricity for the ball races, is bronze-bushed for the driving pinion, and splash lubrication provides a continuous flow of oil over all gears, pinions and bearings. The driving pinion that passes through the load sheave is machined from a single drop forging. The bearing surfaces on the shaft are ground to .001 in.

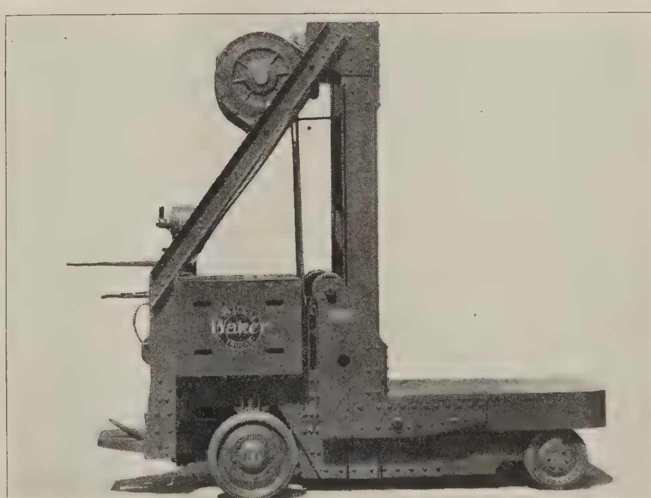
The motor brake is operated positively by the control handle. When the current is on, the brake arms are lifted clear of the drum so that there is no dragging or friction during the hoisting operation. Immediately the current is shut off, the brake arms clamp tightly around the hoisting drum, producing a powerful, positive braking action.

The upper and lower limit safety stops are mechanically connected with the controller and operate the drum brake when the load hook has traveled its limit in either direction. The current is cut off and the brakes are applied the moment the limit of travel is reached. An upper limit stop does not in itself provide maximum safety of operation, but when combined with a lower limit stop the protection afforded is complete.

The steel chain containers can be furnished to hold any length of slack chain up to 60 ft. for ¼, ½ and 1-ton hoists and 30 ft. for the 2-ton hoist. These containers are secured to the under frame of the hoist and do not affect the headroom.

Hy-Lift Industrial Truck

A 6-ton Hy-Lift industrial truck has been developed by the Baker-Rauling Company, Cleveland, Ohio, for handling heavy machine dies and castings at shops, storage sheds and platforms. Both dies and castings have increased greatly in size and weight during the past few years and proven rather destructive to trucks



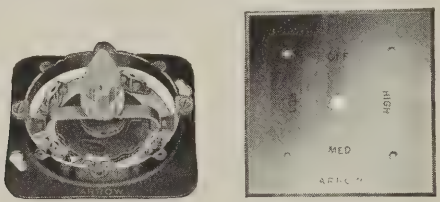
Baker 6-ton Hy-Lift Truck of Unusually Rugged Construction

designed to carry only two or three-ton loads. The six-ton machine illustrated has been designed with the necessary strength and ruggedness for this work.

The main frame of the truck consists of two 8-in. and two 9-in. channels, tied together by a 1-in. gusset plate. The roller frame is fabricated from four 1-in. plates and the 5/8-in. steel platform is carried by four 8-in. channels. The vertical track on which the roller carriage runs consists of two 8-in. nickel-steel I-beams rolled specially for the Baker Company. The power plant employs a Baker totally enclosed series motor, driving through a worm reduction and full floating axle shafts. The driving axle is connected to the frame by means of the patented duplex compensating suspension, which relieves all axle strains and maintains accurate alinement between the axle and truck frame under all road conditions. The hoist is of the two-cable type and the drums are driven by a compound wound motor through a combination worm and planetary reduction.

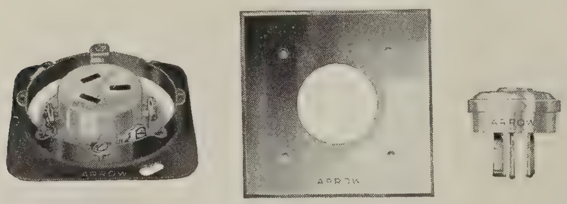
Reciprocating Snap Switches

A number of new types of switches have been added to the line of Heater Switches manufactured by the Arrow Electric Company, Hartford, Conn. The round base line of switches has been extended to include a 54-ampere size



Flush Type Heater Switch and Cover Plate

which will take care of 5 kw. service for electric water heaters and other heavy duty appliances. Other additions include high capacity, 250 volt switches in the round base type on all switches having a 3 in. base or larger, a com-

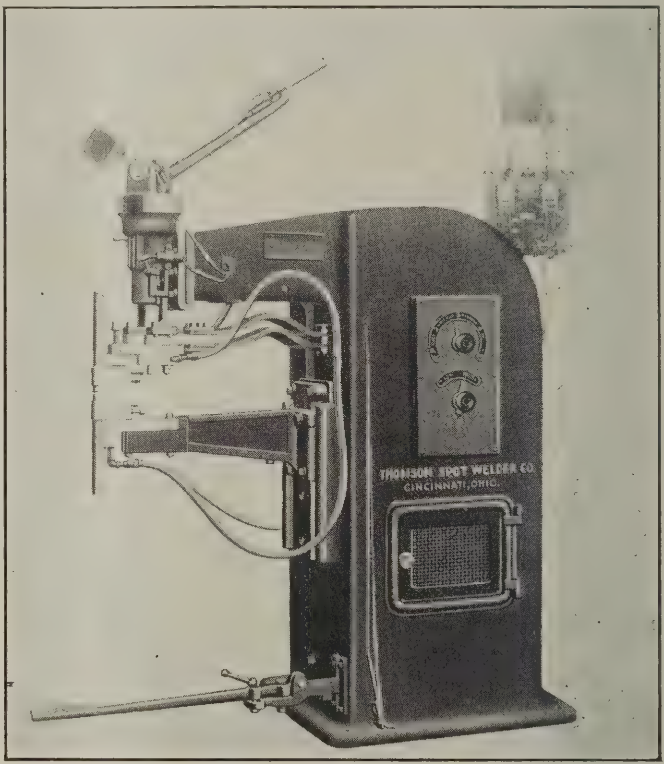


Three-Wire Flush Receptacle, Brass Plate and Porcelain Cap

plete line of new bus-bar range switches with special spacings, heavy duty heater switches and three wire receptacles for flush mounting. All of the Arrow switches are built on a reciprocating principle, permitting them to be operated in either direction.

Spot Welders for Heavy Sheet Metal

One of the machines recently developed by the Thomson Electric Welding Company, Lynn, Mass., is a heavy-duty spot welder designed for handling sheet steel and iron up to 5/16 in. thickness and also soft sheet brass up to No. 14 B & S gage. These machines are built in various sizes, one of which is shown in the illustration, for different kinds of work. The lower horn of the welder is of cast copper and is made as narrow as possible to get into small openings. The top is covered with a brass jacket insulated from the horn itself to prevent sparking should the work rest against the metal at any point. This horn is not made to stand heavy strains and is not recommended for heavy stock



Spot Welder Designed for Heavy Work on Flat Sheets

where considerable pressure is required to bring the stock together for welding. This machine can also be equipped with a swinging table which is secured to the side of the column.

The dies are water cooled and have interchangeable points. For heavier work, a solid die is recommended instead of the water cooled type, the solid dies being cooled by contact with the water cooled holders.

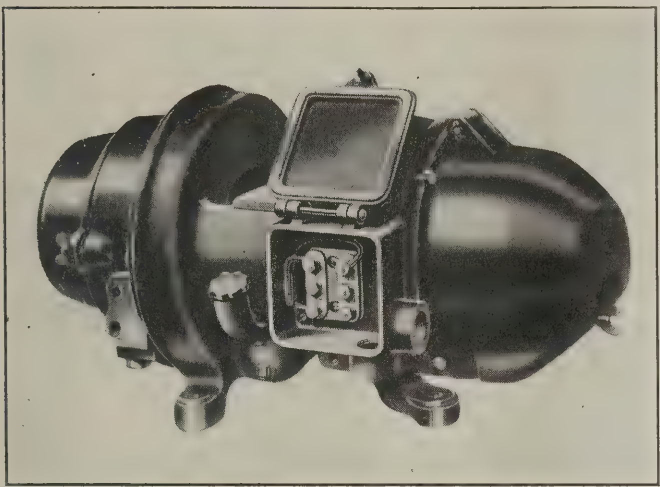
The Thompson spot welders are built in several sizes to handle a large range of work and the various types on exhibit are capable of handling up to 3/16 in. soft cold rolled steel under ideal conditions for welding. These machines have a throat depth in four sizes ranging from 15 in. to 51 in. and are 75 in. high, set up on the floor.

Four-Pole Train Control Generator

An 800-watt turbo-generator set having a four-pole generator for locomotive lighting and train control service has recently been developed by the Sunbeam Electric Manufacturing Company, Evansville, Ind. It is known as type R-4 and is similar in appearance to the R-3 two-pole machine except that it has three feet for mounting instead of four. The turbine ends of the two machines are identical in all details.

The shaft is made heavy to reduce vibration to a minimum and is mounted on two No. 306 ball bear-

ings as required by A. R. A. specifications. The generator has four poles on which the field coils are wound. These poles are fastened to a ring which is removable. After the end bearing is removed, four bolts can be removed from the main casting and the entire field assembly pulled out. There are four brushes and the brush holders are mounted on a ring which can be taken

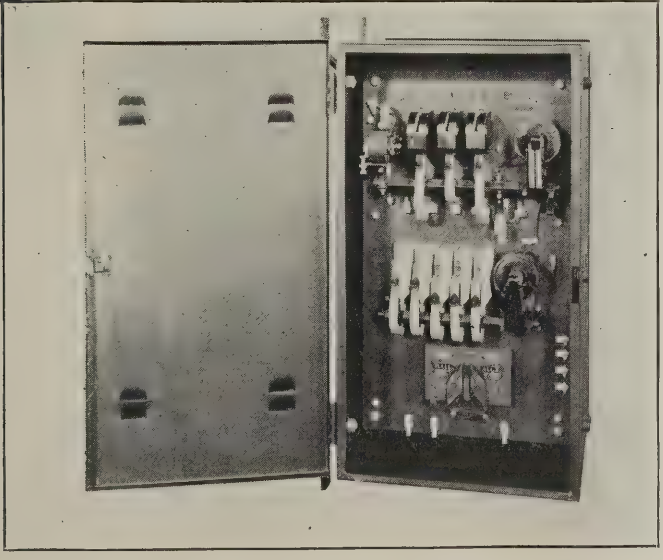


Sunbeam, Type R-4, Headlight and Train Control

out as a unit. The armature is wave-wound and any brush may be lifted without disturbing the commutation or flow of current. The generator is rated at 800 watts, 32 volts and runs at 2600 r.p.m. The machine is totally enclosed and is provided with a water-tight terminal box. The weight complete is 185 pounds.

Induction Motor Starter

A new starter recently placed on the market by the General Electric Company, Schenectady, N. Y., bears the type designation CR-7055-A-1. It is a reversing



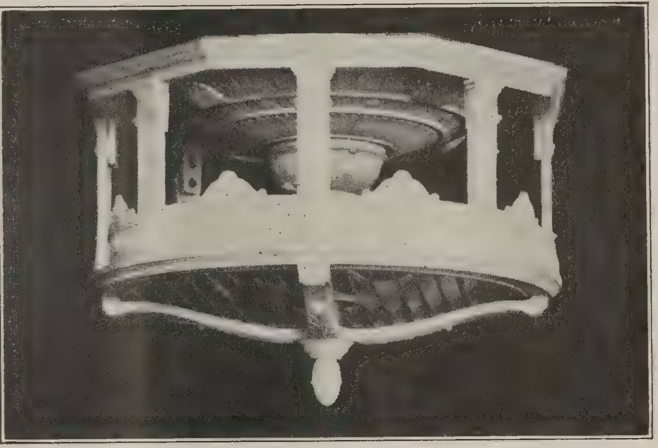
Reversing Starter for Squirrel Cage Motors.

primary resistor starter for squirrel cage induction motors. Two three-pole line contactors are provided with this starter. These contactors are electrically and mechanically interlocked and are mounted back-to-back on the panel. A magnetic time interlock provides a predetermined definite time of from one to three seconds between the closing of the line contactor and of the accelerating contactor.

Two-point starting is provided by a resistor designed to conform to Electric Power Club classification No. 16. A temperature overload relay with an external resetting mechanism furnishes overload protection. The enclosing case is of sheet metal, semi-ventilated, and is provided with feet for wall mounting. When mounted, the panel occupies a position at right angles to the wall. Doors may be locked and are provided at front and back of the panel.

Electric Fans

The Safety Car Heating & Lighting Company, New Haven, Conn., has developed an electric fan for railway passenger cars along somewhat radical lines as is clearly indicated in the photograph. When first introduced it was received cautiously, but later its advantages



A Fan Which is Ornamental as Well as Practical

were recognized and now its acceptance is quite general and its use has reached a point where it has become standard on many railroads.

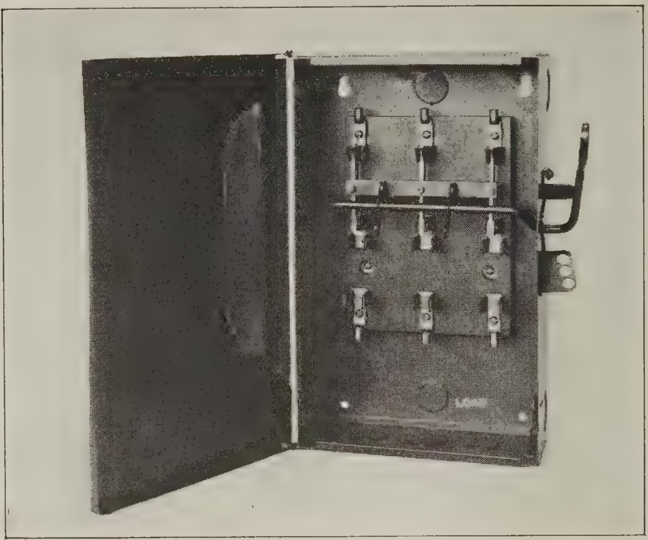
The company is introducing this type of electric fan into commercial fields other than railway cars. The decorative possibilities of this type are an important factor.

A Quick-Break Industrial Switch

A quick-break, safety, enclosed switch has recently been brought out by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. This switch, known as the Type WK-62, is externally operated, totally enclosed, and has a simply constructed quick-break mechanism. It is for industrial and other applications where a disconnect switch is desired.

The stops that limit the travel of the switch arm and the blades are placed on the outside of the box, which simplifies the construction and affords ample room for wiring. Clean cut and easily removed knockouts are provided in the back, sides and the top and bottom ends for any desired arrangement of the conduit. The dia-

mond pointed jaw and the extended blade are used in the WK-62 switch. With this feature, any burning that occurs when the switch is opened does not foul the current carrying area of the blades and break jaws.



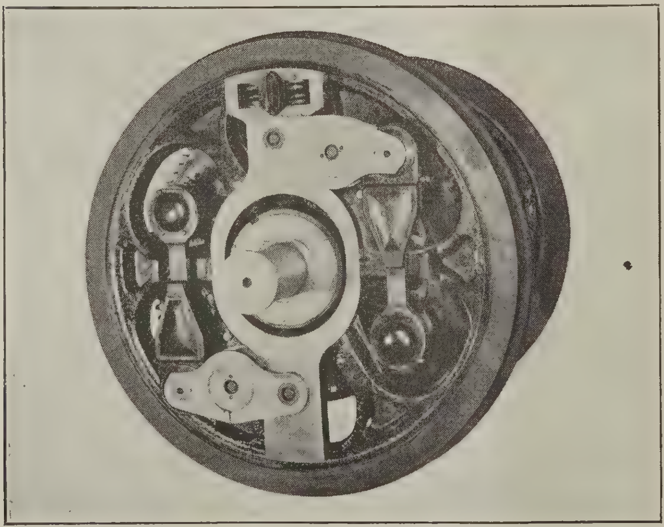
Interior of Box Showing Construction of Switch

The new switch is supplied in capacities from 30 to 200 amperes and is rated at 250 volts d.c. and 250-500 volts a.c., in both the fusible and non-fusible types.

Balanced Link Drive for Electric Locomotives

A link drive for electric locomotives which has been designed to incorporate the greatly desired feature of balance has been developed by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

The mechanism is assembled on the outside of one wheel only of each pair of drivers and, having the balance feature, the drive is symmetrical regardless of concentric or excentric positions of the axles due to irregularities in the track. By the use of balanced link drive, it is possible to obtain a minimum of dead weight at the rail for each driving axle, a condition that is most desirable on all locomotives, particularly those operating at a high rate of speed.



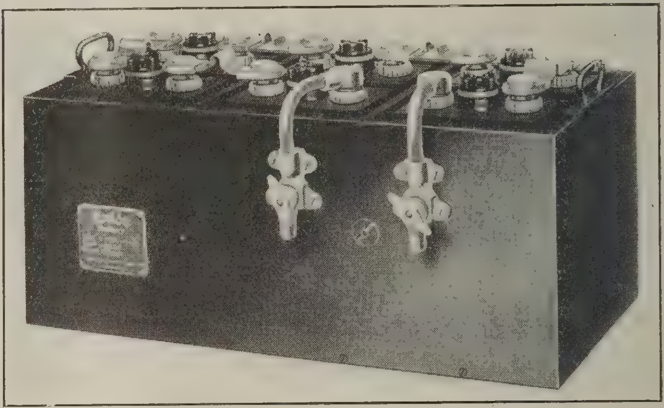
View of Driver Showing Balance

The construction of the mechanism allows ample box movement. A spring cushion in the driving parts absorbs difference of accelerating and decelerating rates of gear rim when the axle and quill are not concentric.

New Storage Battery for Motor Coaches

The Electric Storage Battery Company, Philadelphia, Pa., has developed a new Exide battery designed particularly for motor coach service. The sediment space has been increased considerably and there has also been provided increased space over the plates for the electrolyte. These improvements provide a battery that will perform in service for a long period without attention, requiring water only at periods that can be scheduled with other maintenance repairs.

A special arrangement for sealing the batteries is used to prevent the possibility of any electrolyte escaping through cracked sealing compound. A special post seal nut is provided which allows the use of a ring of grease around the terminal posts. This prevents any corrosion of these parts. The jars and covers are made of a special compound to resist breakage and the plates are of extra thickness to insure longer life.



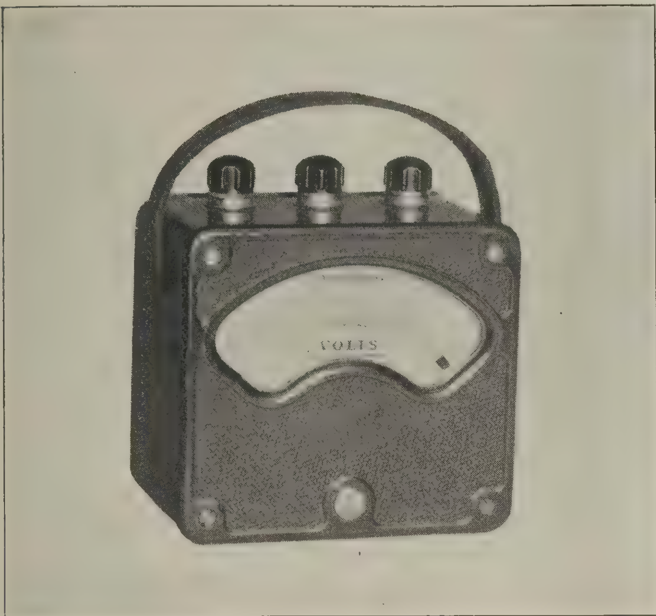
New Exide Motor Coach Storage Battery

Portable Meters for Alternating or Direct Current

The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has introduced a new set of portable indicating instruments that may be used for both alternating and direct current. After a complete analysis of the requirements, a non-residual iron was developed for use in the construction of these instruments, to enable them to function properly for both kinds of current. This complete set of indicating instruments, includes an ammeter, voltmeter and single phase wattmeter.

A beautiful mahogany-veneered, one-piece Micarta case has been designed for the meters, which is strong, resists acids and is of dust-proof construction. It is made in one piece with its inner layers of the same

Micarta that is used for industrial gears. A tightly fitting nickel-plated brass ring, lined with felt, prevents any dust from entering the box once the meter is inserted. As a protection to the meter when it is not in



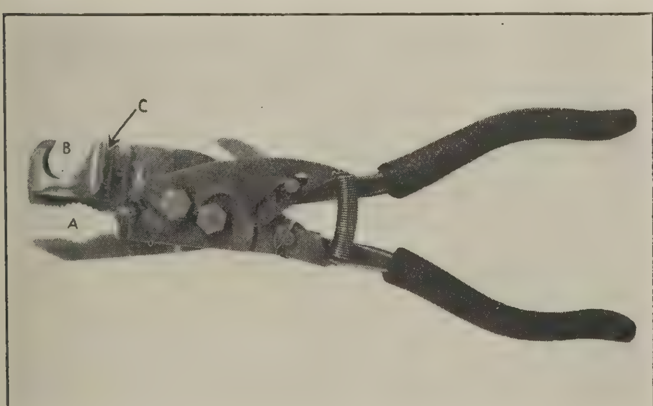
A Voltmeter Typical of the New Line

use, a lid of the same finish as the box itself is provided.

The handle is made of leather and is attached to two nickel-plated brass lugs; it can quickly be replaced in case of damage.

Armored Cable Tool

A tool for working armored or BX cable known as the Triangle Armored Cable Tool is being offered by the Triangle Conduit Company, Inc., Brooklyn, N. Y. The tool is a pair of steel pliers 11½ in. long weighing two pounds. It will strip any single strip armored cable in



The Tool Cuts the Cable to Length and Strips Armor Without Injuring Insulation

sizes 14/2, 14/3 or 12/2 without any adjustment. For stripping, the cable is placed in the jaw C and the handles pulled wide open. This action causes the lower dog or hook to engage with the cable and bend it at a sharp angle. This opens a place for the upper hook or cutter, and when the handles are closed, the cutter goes through the armor without injury to the wire or insulation.

The tool also has an auxiliary pair of wide mouth plier jaws A, which perform the functions of ordinary gas pliers having an extra heavy leverage. The cutting device A is used for cutting the cable to length, including both the wire and armor, and will cut cable or nonmetallic conduit up to sizes of ½ in. outside diameter. The manufacturer claims that both the cutting and stripping blades are good for as many as from 10,000 to 15,000 cars.

The tool eliminates the need for a hack saw and has many advantages when it is necessary to work in tight corners. It has already won the commendation of leading men in the electrical industry.

Yale Elevating Platform Truck

The Yale & Towne Manufacturing Company, Stamford, Conn., is offering a new elevating platform truck, the Yale K23E, which is designed primarily to carry unusually heavy loads. Although this machine is not of the high lift type, it embodies desirable self-loading features. The short turning radius and the narrow width of this machine make it easy to drive in and out of box cars or narrow aisles. Hardened steel steering pivots with bronze bushings and a high pressure lubricating system reduce friction and make steering easy even when carrying a full load. Heavy pressed steel frame members and large elevating links which support the platform admit of carrying the load with an ample factor of safety.

The elevating mechanism is of the triple spur gear type and parts are interchangeable with those of

The Parts of the Yale K Series of Trucks are Interchangeable with other Types of this Manufacturer

other type trucks made by this company. The elevating platform is raised by means of two large eccentrics mounted on the hoist unit shaft which draw the platform forward and upward on the platform links. Mechanical upper and lower limit stops assure simple and safe operation of the lift mechanism. A special feature of the Yale K series trucks is the spur-geared unit power axle —a sub-assembly interchangeable with that used in all models. The standard Yale system of control is used on the truck.

The majority of parts, units and special assemblies of this elevating platform truck are standard. When two or more different Yale K series trucks are used in one plant this interchangeability offers definite operating advantages and economies.

GENERAL NEWS

The Pyle National Company announces the removal of its New York office to rooms 3509-11 Grand Central Terminal Building.

Gibbs Welding Machines Company, Bay City, Mich., manufacturers of electric arc, spot and seam welders, broke ground June 10 for an addition to its factory that will more than double its present floor space.

At Crystal, Nev., on the Los Angeles Line of the Union Pacific, 369 miles east of Los Angeles, early on the morning of June 16, a sleeping car of the Continental Limited, eastbound, took fire—cause not explained —and five passengers were burned to death.

The Norfolk & Western has been granted by the Interstate Commerce Commission an extension of time to January, 1927, in which to complete the installation of automatic train control as required by the commission's order of January 14, 1924.

The Interstate Commerce Commission has reopened its automatic train control proceeding for further hearing, at Washington, on petition of the Kansas City Southern for a postponement of the effective date of the commission's order requiring it to install train control.

A 160,000 kw. turbo-generator has been purchased from the American Brown-Boveri Electric Corporation, Camden, N. J., by the United Electric Light & Power Company, New York. This machine, which will be by far the largest of its kind ever constructed, will be built at Camden, N. J., and shipped to New York on ocean-going barges. The condenser water requirements of the turbine will be 6,000,000 gallons an hour, which is more than the total low water flow of the Delaware River at Port Jervis, N. J.

Pennsylvania Orders Seven Electric Locomotives

The American Brown-Boveri Electric Corporation has received orders for the electric equipment of seven electric locomotives from the Pennsylvania Railroad. The mechanical parts of the locomotive will be built at the Pennsylvania shops in Altoona, Pa. The electrical equipment will be built at the Camden, N. J., plant of the Brown-Boveri Corporation.

The locomotives will operate either from a 600-volt, direct-current third rail, or from an 11,000-volt, alternating-current overhead trolley. They will be single cab locomotives similar in appearance to the L-5 type locomotives now in service in the New York terminal. By changing the gear ratio, the locomotives can be used for either passenger or freight service. The locomotives are designed to haul a 16-car passenger train at 75 miles an hour, or, as freight locomotives, to haul a tonnage train at 35 miles an hour. Each locomotive will have four driving motors, with a combined continuous rating of 3,640 hp. The driving wheels will be 80 in. in diameter and the load on each driving axle, 75,000 lb.

When these locomotives are placed in service, the motive power displaced will be transferred, it is understood, to the Long Island division of the Pennsylvania. Subsequently, the new locomotives are expected to be used on the main line electrification project of the Pennsylvania which is being initiated and is now under construction between Philadelphia, Pa., and Wilmington, Del., a distance of 28 miles. The new locomotives will be used individually or in multiples, according to the character of the trains to be handled.

Radio Successfully Used on Long Freight Train

The recent interesting experiment on the Pennsylvania demonstrating the value of telephone communication between the caboose and the locomotive of a long freight train (by means of wires strung along the tops of the cars) is now supplemented by a successful test, on the New York Central, of radio apparatus, for carrying out such communications without the use of wire conductors.

Working in conjunction with the Zenith Radio Corporation, of Chicago, E. C. Keenan, general superintendent of telegraph and telephone of the New York Central, has made a series of experiments on that company's line between Elkhart, Ind., and Pinola, about 50 miles, demonstrating that the Zenith apparatus works successfully on trains of 100 cars or longer. The train which was used consisted of locomotive No. 2626 with 11 cars and a caboose. It started from Elkhart at 4 p. m. and experiments were kept up for four hours. Within this time there was a severe electrical and rain storm, but there was no interference with the conversation, nor was there any trouble when the train was beneath steel bridges. The passing of another train on the adjacent track did not interfere.

To determine the value of this arrangement on a long train or in any case where a train might break in two, a stop was made at Hudson Lake and the locomotive cut off and run ahead about four miles. Throughout this entire distance communication was kept up without difficulty, and always with good loud-speaker volume. The trainmaster, conductor, engineman and brakeman who participated in the experiments were enthusiastic in their praise.

The radio equipment used in the caboose—and the same in the locomotive—consisted of a combined receiving and transmitting set with the necessary generator, batteries and loud-speaking receiver. An antenna consisting of 32 feet of ½-inch brass pipe supported on special brackets fixed 12 in. above the cab roof, was installed on the locomotive. The antenna on the caboose consisted of 32 ft. of rubber-insulated wire mounted on supports. The transmitting-receiving sets contained seven tubes, three for transmitting and four for receiving. The transmitting tubes consist of 50-watt oscillator, 50-watt modulator and 7½-watts for speech amplification. A wave length of 115 meters was employed.

New York, Westchester & Boston Buys Multiple Unit Cars

The New York, Westchester & Boston Railway has contracted for 10 new multiple unit passenger cars. The new equipment is required to accommodate a rapidly increasing burden of traffic which, during the first five months of 1926, has gained nearly 14 per cent over the corresponding period in 1925, and promises to reach a total of 11,500,000 for the current year.

Inasmuch as the N. Y. W. & B. passenger schedule recently was revised to provide 20 additional trains daily, making a total of 245, there will be no immediate further additions. The new cars will be used in lengthening trains already scheduled.

The 10 cars will cost approximately $450,000. They will be built by the Pressed Steel Car Company, in Pennsylvania and equipped electrically by the Westinghouse Electric & Manufacturing Company at the Harlem shops of the railroad. The cars should be completed early in September.

The cars will be 72 feet long, seat 80 persons and weigh 66 tons each. There will be two 340-horsepower motors per car. The six entrances of each car will be of electric-pneumatic operation, as will the ventilating system, which will be of the Garland high-speed vacuum type.

The Management of a Pullman-Car Hotel

The extensive use of sleeping cars as stationary lodgings for the accommodation of the great number of Shriners who gathered in Philadelphia for their annual conclave on June 1, 2 and 3, was in reality the establishment of a number of well equipped villages. Cars were parked at a dozen or more different places in the city, both by the Pennsylvania and the Baltimore & Ohio.

One of these "villages," that at the Park shop freight-car repair yard of the Pennsylvania, is described in an article in the Pennsylvania News of June 15. Eight tracks of this yard, devoted to the repair of freight cars, were cleared, and on them were placed five trains of sleeping cars for the use of Medinah Temple, of Chicago, about 1,750 persons, together with necessary supply cars. Among the many details involved was the construction of boardwalks suitably located between the tracks, pipe lines for hot and cold water and conduit lines to furnish illumination and telephone service. The trains were numbered from 1 to 5, inclusive, and were designated by color as "Red Special," "White Special," "Blue Special," "Orange Special" and "Green Special."

Located at a convenient distance were two express cars which were converted into hot and cold showers for the use of the men. These cars were reconstructed inside so as to provide twelve individual compartments for shower baths, with a hot-water heating plant, three large boilers, each of 144 gallons capacity. A car similar in design and equipment was assigned for the use of the ladies. This feature, much praised, was prepared by J. P. Yergy, general foreman, West Philadelphia Shops.

A combined car was fitted up for the serving of refreshments between meals, also a car used as a tailor shop, with every facility for mending and pressing, which was very much in demand.

Seven dining cars with a retinue of 112 employees provided dining room service in accordance with Pennsylvania Railroad standards. The various menus for the entire time (eighteen meals) between May 30 and June 5, included dishes to suit radical changes of appetites due to extreme hot or unseasonably cold weather.

In addition to the facilities on wheels a barber shop was established in the carpenter shop with three chairs. Opposite, in the same building, was a post office and bureau of information, with adequate telephone service. The electric lighting system included, between cars on the eight tracks 75-watt lamps attached to the marker lamp holders on the cars. An emergency system was arranged whereby the cars were divided into eight groups, which allowed ample voltage of alternating current for the lighting of each car. This provided for unlimited use of light.

Other working forces included 22 men assigned to look after watering and icing, there being one ton of ice used daily.

Within 24 hours after the departure of the last train, the yard was cleared of all temporary facilities and once again restored to its normal function as a freight car repair yard.

Illinois Central Operates Test Suburban Train in Connection with Electrification

A special train is being operated by the Illinois Central near Pullman, Ill., between 95th and 115th streets, to test new equipment that will be used on the electrified portion of the line and to train motormen in the operation of the new suburban cars. This particular stretch of track, about two miles in length, is energized at 1,500 volts direct current from the Front avenue substation of the Commonwealth Edison Company at Kensington it is planned to operate each car under test for about 300 miles before it is placed in service. A. H. Woollen, equipment engineer of the Chicago Terminal Improvement department of the road, is in direct charge of this test train. Several men are being trained as in-

structors to take charge of the training of prospective motormen. For this purpose a demonstration room, equipped with all types of control equipment, has been set up at the Randolph street suburban station. The training period, it is planned, will cover about two weeks' time.

Fourteen Passengers Killed at Gray, Pa.

In a rear collision of passenger trains on the Pennsylvania at Gray, Pa., 50 miles east of Pittsburgh, on the night of June 16, about 11:45 o'clock, 14 passengers and four employees were killed and 13 passengers and one employee were injured. East bound passenger train No. 50, the Pittsburgh-Washington Express, which had been stopped because of a ruptured air hose, was run into by the following passenger train, No. 40, the Cincinnati Limited, which consisted of two locomotives, a club car and nine sleeping cars. Both locomotives of No. 40 were overturned and the club car was wrecked. All four tracks were blocked. Five passengers in the club car of No. 40 and nine in the rear sleeping car of No. 50 were killed. Both enginemen and one fireman of No. 40 were killed and the baggageman on that train was reported missing.

A statement issued by the railroad company said that the flagman of No. 50 had gone back and placed torpedoes and fusees, and that when he was recalled he was passed by train No. 40 before he reached his own train; No. 40 having passed the signal [presumably an automatic block signal] as well as the burning fusees and the torpedoes.

Personals

Alfred C. Turtle, formerly shop electrical engineer for the Canadian National Railways has recently accepted the position of chief engineer for the Western Engineering Company, Ltd., manufacturers of Hevi-duty electric furnaces for steel treatment and metallurgical work of all kinds, power plant and combustion machinery, as well as transformers and distribution equipment. Mr. Turtle's headquarters will be at 791 Erin Street, Winnipeg, Man., Canada.

C. J. Zeigler, formerly chief electrician of the Florida East Coast Railway Company, was recently appointed service engineer of the Simplex Wire & Cable Company, Inc., for the Florida-Cuba district, with headquarters at St. Augustine, Fla. Mr. Zeigler was born in Lancaster, Pa., on June 25, 1884. He graduated from the high school at that place and later from the Bliss electrical school with a master electrician's certificate in 1902. From June, 1903, until September, 1905, he held a position of foreman for the Allegheny County Light Company at Pittsburgh, Pa. He then accepted a position of general foreman of construction for the Pennsylvania Steel Company at Steelton, Pa., where he remained until July, 1906, when he accepted a position as foreman of shop plant equipment at the General Electric Company at Pittsfield, Mass. In February, 1909, Mr. Ziegler became chief electrician of the Florida East Coast Railway Company, with headquarters at St. Augustine, and early in 1926 accepted his present appointment with the Simplex Wire & Cable Company.

Obituary

Samuel H. Dannatt, manager of the New York office of the Electric Service Supplies Company, Philadelphia, Pa., died May 30th at his home in Mount Vernon, N. Y. Mr. Dannatt was associated with this company for five years, and made many friends among his customers. He was forty-three years of age at the time of his death. Prior to his connection with the Electric Service Supplies Company, he was associated with the Westinghouse Electric & Manufacturing Company, the Electric Power Equipment Corporation, and the Una Welding & Bonding Company.

Trade Publications

Automatic Pumping is the title of a new twenty-four page booklet issued by Barrett, Haentjens & Co., Hazleton, Pa. The subject is treated from a purely technical standpoint and several new methods of making centrifugal pumps automatic are described.

The Graybar Electric Company has recently issued a 48-page illustrated fan catalogue for both alternating and direct current circuits. All types of fans are listed, including non-oscillating, oscillating, ceiling and ventilating and exhaust fans.

The Sangamo Electric Company, Springfield, Ill., has just issued a 20-page illustrated booklet giving complete instructions for the Sangamo D-5 watt-hour meters. Complete details of all of the parts are shown together with circuits in which these meters are used.

Automatic Switching Equipment is the title of a 23-page bulletin just issued by the General Electric Company and bearing the number GEA-295. The bulletin is well illustrated and describes the application of this equipment to railway service, hydro-electric generators, mining and industrial service, central station service, etc.

The American Electric Fusion Corporation, Chicago, has just published the first issue of its booklet "A. E. F. Welding Illustrated." The booklet is to be published monthly and it is the aim to have each issue contain something worth while to those interested in electric welding. The first issue contains a short illustrated article on the principles of electric spot, butt and seam welding.

Floodlighting Projectors is the title of bulletin No. 216 recently issued by the Electric Service Supplies Company of Philadelphia. The bulletin contains 72 pages and is well illustrated with photographs and drawings in which applications of the Golden Glow and Crystal Mirror reflectors are described in detail. All of the various kinds of flood lighting equipment manufactured by the company are shown and complete information as regards type, dimensions and prices, is furnished. The first part of the bulletin is devoted to a discussion of the subject of flood lighting in general and several illustrations are given, showing the application of this method of lighting to railroad yards. Flood lighting performance curves are given, showing the different results obtained with various lighting units, reflectors, mounting heights, etc. From these curves, of which there is a large number, it is possible to pre-determine to a considerable extent the light values that may be obtained under a given set of conditions and equipment.

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Electric Refrigeration

In a letter published recently in the New York Times under the title "Strained, Cooled Air for Railroad Traveler," the writer looks forward to the day when one will be able to ride in a car in which the windows will not be opened, as the air will be forced in through a cleaner and through coils of cooled pipes.

This idea will be considered unnecessary and impracticable to most of the readers of the *Railway Electrical Engineer,* but it will have much interest for many railroad passengers. If electrical or mechanical refrigeration does find a place in railroad trains, it will probably be used first on refrigerator cars. In fact a considerable amount of investigation work concerning its possibilities has already been done. Those who have considered the problem are divided into three groups: those who think power for refrigeration should be obtained through train lines from a motor-generator set mounted on the tender, those who think axle generators should be used and those who think the entire scheme impracticable. The actual power requirements would be about 5 kw. per car. On an electrified line it would be a relatively simple matter to take this additional amount of power from the trolley, but as it must come from steam locomotives, it can readily be seen that power required for refrigeration of a long train would amount to an appreciable part of the total power of the locomotive.

The amount of power required and the probable cost of an installation are the greatest difficulties to be overcome, but it is entirely possible that the improved refrigeration would save enough perishable freight to warrant the additional cost of the equipment and its maintenance. With a greater amount of power available other things could also be accomplished such as the operation of locomotive auxiliaries, radio communication between the front and rear end of trains, etc. As a matter of fact the subject is very new and it may happen that some form of absorption refrigerator without moving parts which can be operated from an oil or gas flame will meet the requirements. Such a device for household refrigerators has been recently placed on the market by Electrolux Ltd., London, England. Abstractedly, the subject is an example which shows a trend. Constantly increasing service requirements are every day being met by the use of new mechanical and electrical apparatus and opportunities are constantly being presented to both the railroad and the supply field which call for the best the personnel has to offer.

The Illinois Central Electrification

There are a number of factors concerning the Illinois Central electrification which are and will be of especial interest to railroad and electrical men. These do not include the much discussed questions of economics and selection of system. The railroad lines have been electrified to conform with city requirements and it will probably not be possible to justify the electrification on the basis of economic advantages. The 1500-volt direct current system was chosen because it is best suited for electrification of the Illinois Central urban lines. The d.c. motors are particularly suited to multiple unit car operation and the voltage is high enough to reduce the amount of overhead copper required without introducing difficulties in car design which might be caused by insulation, control, and space requirements if a high voltage were used. The 1500-volt system would probably not be chosen if the whole railroad system were to be electrified, but such a consideration will probably not be made for so long a time, that the need for adapting the urban voltage to a system voltage does not warrant consideration.

Among the points of real interest are the cars. By using a trailer and a motor car semi-permanently coupled together, all the advantages of having four motors for series and series-parallel connections are obtained and the damage to motors which is often caused by hauling too many trailers with one motor car is eliminated. The bodies of the car are made of copper bearing steel, the inside sheathing is aluminum, the roof sheets and lower deck sheets are aluminum alloy and the doors are made of sheet aluminum. This design provides a car which is durable with ample head room and one which can be accelerated quickly without undue waste of power.

The type of overhead construction used is unique and much can be learned from a study of the methods used to install it quickly with a minimum of labor without interfering with traffic.

Gas-welded bonds are used for bonding rails and for applying grounds. While this is no longer a new practice, it aids materially in establishing a precedent and in overcoming a lot of reluctance on the part of railroad operators who have frowned upon the process.

A 1500-volt connection is carried through the couplers and while this does not carry heavy currents, it shows that with new methods, 1500-volts is not so unmanageable as was once supposed.

Mercury arc rectifiers are used in conjunction with

rotary convertors for supplying the 1500-volt power. This is the first installation in the country of large power rectifiers, and if they fulfill all of their possibilities, it is not impossible that they may some time entirely supplant rotating machinery for this purpose.

It is unfortunate that the installation cannot be warranted on a purely economic basis, but students of electrification will find much to increase their knowledge of the science of electrification by studying the Illinois Central installation and in watching the various phases of its operation.

Possibilities in Communication

Communication in railroad service is by no means new, although from time to time unusual applications of some novel means of communication between two points are brought out and when they are, they are worthy of note. In the article on page 254 of this issue, the use of a teleautograph is mentioned in connection with the movement of cars to and from the yard for electric repairs. The teleautograph has been used on railroads for a number of years but this particular application seems rather unique. Issuing orders on the teleautograph over the signature of the superintendent, carries with it a degree of authority which permits of no misunderstanding. Moreover, a teleautograph with its multifold writings, records at numerous points about the yard and advises all concerned just where and why certain cars are dispatched in the way they are, and thus relieves any doubt regarding the disposal of any particular car or cars. Communication is of paramount importance in yard operation and in this particular case, a teleautograph has resulted in greatly simplifying dispatching of cars for electric repairs.

Headlight Maintenance Records

If all railroads, or even a number of them, would keep records of headlight maintenance on a comparable basis, much valuable information would soon become available. For example, some roads believe in reclaiming practically all parts of headlight equipment. Others believe that a minimum of reclamation work is best and that it is usually cheaper to replace a worn or damaged part than it is to repair it. Accurate records, compiled on the same basis for a number of different roads, would do much toward solving the question of what kind of maintenance work is most satisfactory.

The situation in the train control field will, before long, make it desirable that the cost of maintaining headlight equipment be known. Eventually, the different kinds of train control in service will be reduced to a few. The question of what kind to use will be governed first by dependability and second by the cost of operating and maintaining the equipment. It is necessary, therefore, that the cost of maintaining the equipment be known. When power for train control is obtained from the headlight generator, it will be necessary to make a charge to the train control maintenance for this or to separate the headlight costs from the others. If headlight maintenance costs are known this can be done.

The lighting equipment constitutes only a small part of a locomotive and probably for this reason very few realize the magnitude of maintenance costs. Recent estimates made by the *Railway Electrical Engineer* show that the railroads of the United States spend a minimum in labor and material of $11,000,000 per year for maintaining locomotive lighting equipment. If knowledge of how this money is spent is compiled by different roads on a comparable basis, it is entirely possible that the savings effected will amount to a considerable sum. The methods of obtaining records can and should be very simple. What is necessary is that a few good methods be suggested and that the best of these be adopted by all.

An Open Question

The extent to which the Lehigh Valley carries the maintenance of its fleet of electric trucks in use at Manchester Transfer, gives rise to the question of just how far it is practicable to carry work of this character. In the case in point, the railway company includes in its maintenance the complete rebuilding of its electric trucks when wear and tear renders them unfit for further service. Its policy in this respect is undoubtedly sound as is indicated from the fact that it is able to rebuild the trucks cheaper than it can buy new ones. The trucks used at this plant were originally of light construction, built at a time when such equipment was comparatively new. They lasted many years beyond their normal life even in such strenuous service as they encounter in the work at the transfer station. The company has found that it can rebuild them at a comparatively low cost and credit is due those who have been able to achieve these results.

There is, however, another side to the matter and one which makes it rather an open question, as to just how far such maintenance should be carried. In the case of the Lehigh Valley, the material cost of rebuilding a truck is practically the only charge made against its construction. In other words, no overhead charge is taken into account. The force of employees is the same regardless of whether or not the maintenance work includes the rebuilding of trucks. If an overhead charge were made in connection with this work, it might prove that the saving made between the actual cost of truck construction and the price of the purchased product would not be so great.

It probably always will be an open question as to just how far maintenance of any equipment may be carried economically. There are many factors to be taken into consideration, none of which can safely be omitted if a correct appraisal of the cost of maintenance is to be arrived at. The cost of material is one of these factors; the readiness with which the material can be obtained is another; overhead charge is still another and there are others.

Maintenance of equipment will always be a vital matter in railroad operation. When, however, maintenance is carried to the extent to which the Lehigh Valley has done with its trucks, it borders closely on manufacture, and there are relatively few who believe that railroads can profitably engage in the business of manufacturing.

Illinois Central Train on the Four-Track Section in the Electrified Zone

Electrification of I. C. Suburban Service Completed

Rapid Construction Progress Made During the Past Year in Spite of Heavy Terminal Traffic

ON July 21, 1926, the first suburban trains were operated electrically on the Chicago terminal of the Illinois Central, marking the completion of the first stage of the electrification of both freight and passenger facilities within the city limits as provided for by the Lake Front ordinance of July 21, 1919. The suburban service, all of which is now electrified, totals 106.2 track miles with schedules planned for the operation of 414 trains in a normal week day. Lengths of runs between scheduled stops vary from 0.34 mile in local service to 14 miles in "special" service, the average runs being 0.6 mile for locals, 0.95 mile for expresses and 1.7 miles for "specials."

For this service there will soon be available 260 multiple-unit cars consisting of 130 two-car units made up of a motor car and trailer semi-permanently connected together for operation at 1,500-volts d.c. through an overhead contact system. An appreciable saving of time is possible with the new equipment, as compared with steam operation. The straight line acceleration rate of the new units is 1.5 m.p.h. per sec. and their braking rate is 1.75 m.p.h. per sec. On level tangent track and with average voltage at the pantograph they have a balancing speed of 57 m.p.h.

The electrified track layout devoted exclusively to suburban traffic terminates on the north at the temporary station at Randolph street, there being two main tracks and two equipment leads south as far as Roosevelt road, a distance of 1.2 miles. Continuing south to 51st street, five miles, there are six main tracks, two each for "special," express and local suburban trains. The next eight miles of line south to Kensington (115th street) comprises four main tracks, two for "specials" and two for the joint use of express and local trains. A double-track main line continues south from Kensington to the southern terminus of the suburban system south of Matteson, Ill., a further distance of 13.8 miles. The South Chicago branch, a double-track line, 4.5 miles long, joins the main line through a "duck under" crossing at 67th street, while immediately south of Kensington the single-track Blue Island branch, 4.4 miles long, joins the main line. In addition to this total of 106.2 miles of electrified suburban main tracks there are 16.3 miles of electrified yard storage tracks with a capacity of 384 cars.

Traction Power Supply—1,500-Volts D. C.

After an exhaustive study of four different systems of electrification the decision was made to use a d.c. distributing voltage of 1,500, with a permissible variation from 1,400 volts to 1,550 volts under all conditions of load. A careful cost analysis led to the decision to purchase all the d.c. energy from the Commonwealth Edison Company. The problem of furnishing this d.c. power supply for operation of the suburban trains presented several features requiring study before a solution was reached. Service requirements were severe; heavy trains were to be moved at high accelerating rates, at relatively high speeds and with frequent stops. It was essential that reliability of service and economy be considered. Seven substations were found necessary. Automatically regulated field control synchronronous converters were chosen to furnish the major portion of the traction supply, with mercury arc rectifiers in several of the substations to furnish the remaining portion. Under the present service demands there is one reserve or spare unit in each substation. It is planned to add additional units to maintain this safety reserve as service demands increase.

A. C. Supply to Substations and Switching Equipment

The a.c. supply to substations is 12,000 volts, 60-cycle, 3-phase, 3-wire, fed through underground cables to East 16th street, Brookdale, Cheltenham, Front avenue and Laflin street substations, and 33,000 volts, 60-cycle,

3-phase, 3-wire, fed from overhead lines to Vollmer road and Harvey substations. All synchronous converter units are of General Electric Company's manufacture, being rated at 3,000 kw., 1,500 volts d.c. Each unit is composed of two 1,500-kw., 600 r.p.m. 750-volt, 60-cycle, shunt-wound synchronous converters connected in series. Each converter unit is designed for a load rating of 150 per cent for two hours, or 300 per cent for one minute, beginning with the machine at or below normal load temperature. These loads apply also to the transformer. The converter unit is designed to give a voltage on the direct current end of 1,525 volts at no load, to 1,425 volts at 300 per cent load when rated voltage is maintained at the high tension terminals of the converter transformer. This gives a 25-volt margin on either side of the railroad requirements for distribution voltage of 1,400 to 1,550.

For voltage regulation there is provided in each substation a novel counter e.m.f. set, a four-circuit motor-operated rheostat and a Tirrill voltage regulator. This equipment is designed to control all converter sets in operation and to hold the d.c. voltage to definite values for any converter load up to 300 per cent rating, provided the rated voltage is maintained at the transformer primary. For primary voltages above or below normal, the d.c. voltage will be held at the proper values, providing the reactive kva. limits on the converters are not exceeded. While the regulator set appears complicated

Each End of a Motor Car Trailer Unit Is Equipped with an Automatic Coupler Containing 2 Air Lines and 39 Control Contacts

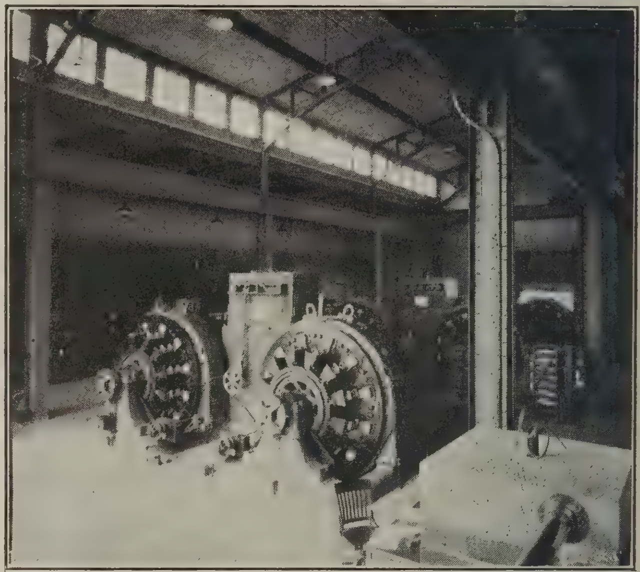
it really does nothing more than could an operator constantly standing at a manually operated field control converter watching the load fluctuations and continually adjusting the d.c. voltage. The regulator set which was specially developed for this service merely supplants the operator and does the "thinking" mechanically and automatically.

High Speed Air Circuit Breakers Used

Each converter group is provided with positive and negative high speed air circuit breakers on the d.c. side. The positive high speed breaker is designed to trip out on reverse current only. Suitable control switches and indicating lamps are provided for operation. An alarm circuit is provided so that in case of automatic tripping a lamp will be lighted and an audible alarm sounded. The negative high-speed breaker is designed to trip on overload and introduce a current limiting resistor in the circuit. Its control is somewhat more complicated than the positive breaker as provision is made for automatic reclosure if the fault is removed within a predetermined time.

Rectifier Equipment in Substations

The first installation of large mercury arc rectifiers in this country for converting alternating current to direct



Interior of the East 16th Street Substation, Showing Two 3,000-K. W. Synchronous Converter Units

current for traction purposes is that included in four of the substations of the power company for furnishing part of the d.c. supply. Small rectifiers of this type have been used in electric railway service, but none approaching 3,000 kw. capacity as here installed. Two Brown Boveri and two G.E. mercury arc rectifier units are employed. One Brown Boveri unit is used at the Brookdale substation and the other at the Harvey substation, both being rated at 3,000 kw. at 1,500 volts d.c. Each unit is composed of two 12-anode mercury arc rectifier bowls with one transformer per bowl. Each bowl is rated at 1,500 kw., 1,500 volts d.c. These rectifier units have load ratings somewhat similar to those of the converters; 150 per cent load for 20 min. and 300 per cent load momentarily. The d.c. voltage regulation is 1,500 volts at 5 per cent load, 1,500 volts at 100 per cent load and approximately 1,360 volts at 300 per cent load. At loads less than 1 per cent of full load, there is a steep voltage rise. The two General Electric rectifier units used, one at Laflin street and the other at Vollmer road substations, are both rated at 1,500 kw. at 1,500 volts d.c. Each unit is composed of two 6-anode mercury arc rectifier bowls with one common transformer per unit. Each bowl is rated at 750 kw., 1,500 volts d.c. These rectifiers have load ratings of 150 per cent load for 20 min., 200 per cent load for 5 min. and 300 per cent load momentarily. The d.c. voltage regulation for the Laflin

street rectifier unit (which will have no automatic voltage regulating device) is from 1,550 volts at light load to 1,340 volts at 300 per cent load.

D.C. Feeder Equipment in Substations

All 1,500-volt d.c. switching (except Brown Boveri Company's rectifier control and converter negative breakers) is done through the medium of G.E. d.c. truck Type-JR, high speed air circuit breakers. Feeder breakers are set to trip on forward shorts only, operating on rate rise of current through the use of an inductive shunt in parallel with the series trip coil of the breaker.

To Reduce Car Weights, the Inside Sheathing, Roof Sheets, Lower Deck Sheets and Doors Are of Aluminum or Aluminum Alloy

They will open the circuit on short circuit in 0.010 of a second. The positive machine breakers are set to trip on reverse current only, and embody in this setting the rate of rise high speed trip feature as just described. Supervisory control of all feeders is provided for, the G.E. selector supervisory equipment being installed. With this system either the railroad's power supervisor or the operator may open any feeder and either may lock open and prevent the closing of any feeder by the other party.

The d.c. meters at all substations except Front avenue are connected on the negative side of the traction supply. One Sangamo d.c. shunt type mercury watt-hour meter is used per unit, its shunt being connected in the negative unit lead.

Power Service Contract Includes Means for Determining Maximum Demand and Energy Consumption

In brief the service agreement between the railroad company and the Commonwealth Edison Company covering the furnishing of alternating and direct current runs for an initial period of 10 years with the privilege of renewal by the railroads for four additional 5-year periods. Until complete suburban service is initiated all power furnished will be billed at a flat rate per kilowatt-hour. After complete operation is effected the contract provides a sliding scale maximum demand charge payable monthly which decreases after each 5,000 kw. of demand up to 15,000 kw. and remains stationary thereafter. In determining the maximum demand for any month the average of the greatest loads during one hour on each of three different days is taken. The railroad is further protected against excessive demand charges by provisions covering various abnormal conditions. The energy charge which is in addition to the maximum demand charge is on the monthly sliding scale basis, decreasing after the first 5,000,000 kwh. and again after the next 2,500,000 kwh. In determining this energy charge the contract provides that the cost of coal to the Edison Company and the heat value of the coal used must be taken into consideration.

Construction of Overhead Distribution System Presented Several Problems

Due to the comprehensive electrification plan providing for the conversion of freight service north of Roosevelt road by 1930 and south of there by 1935, and possibly also through passenger service by 1940, depending upon the type of propulsion used by the roads in the future lake front terminal, the present suburban facilities have been designed with future requirements in mind. This is true particularly of the overhead catenary structures, which in many locations are at present uncompleted but self-supporting units of larger bridges that will ultimately span the entire width of the right of way. Because of the number of overhead railroad crossings, interlocking plants, multiple track junctions and special track layouts (except for moderate stretches of double-track line south of Kensington, 115th street), there is no continuous section over a mile in length where only standard catenary structures are used or where standard spacing and normal height of contact wires are maintained. All this rendered the construction work much more difficult than would be the case in any section of line outside of a busy terminal. Added to this was the inconvenience of carrying on the work under an extremely dense traffic, which in the section north of

Type of Catenary Construction Over Crossovers at Kensington Interlocking

Roosevelt road made it advisable to do much of the electrical work, including the rail bonding at night. From the 51st street interlocking north, much of the overhead work over certain tracks was done on Sundays. All construction work was subordinated to traffic requirements, no interference with train schedules being permitted.

A further incentive toward devising the most efficient construction methods and one which demanded the greatest co-operation from all the forces on the job, was the relatively high cost of labor due to local conditions. This was kept constantly in mind in designing new materials

and in ordering materials, to reduce the field labor wherever possible. Special construction methods and tools were developed by the contractor to perform the work of stringing transmission and catenary wires, placing hangers and clipping in, on a production basis making the fullest use of work train equipment.

The vertical loads on the catenary foundations are comparatively light and for all permanent work concrete foundations of the gravity and side bearing types have been used. For the two-track or single-track bracket construction gravity foundations having a cross-track length of 12 ft., containing about 7½ cu. yd. of concrete are used where track centers permit without extensive track shoring. Where narrow track centers prevail, equivalent side bearing foundations have been installed with a bearing area of 65 sq. ft. All foundations are reinforced and set with the steel structure well above the ground level, using a 1:2:4, mixture for the cap and a 1:2½:5 mixture for the body of the foundation. Normally the top of the foundation is six inches above the top of the rail.

An ingenious side bearing driven type of foundation was installed in the fall of 1924. This involved the use of a steel shell 24 in. in diameter which was driven the required depth, after which the follower was withdrawn, the steel reinforcing placed in position and the shell filled with concrete. Immediately after filling the shell it was pulled out of the ground which allowed the concrete to settle to about two feet below the surface. A steel grillage holding the foundation bolts was then fastened to the channel iron reinforcing and the top capped with concrete. The use of this type of foundation was abandoned in 1925 for the gravity and side bearing types because of the lower prices then prevailing.

Catenary Structure of Latticed Angle Construction Erected by Company Forces

Where there are four or more tracks, that is, between Randolph street and Kensington, the structures consist of built-up columns and trusses of latticed angle construction, spaced normally 300 ft. on tangent track. Except at signal locations, the structures as now installed serve only the suburban electrification. While these structures vary in certain respects they are built up of standard sections which have been adopted for all types. That is, the columns consist generally of four 4-in. by 4-in. angles, laced, with a depth across the track of 15, 16, or 18 in., while the trusses are built up from four 3½-in. by 3½-in. angles, legs out, and laced inside with depths of 3, 4, 5 and 6 ft. depending upon the lengths of the spans. Differences in loading have been taken care of with the use of angles of different thicknesses. By flattening the ends of all lacing members and riveting them direct to the angles the use of intermediate plates has been eliminated and obstructions to the view reduced.

Single columns with light brackets are used in the double-track territory between Kensington, Ill., and Matteson and on the South Chicago branch, where tracks are spaced either 16 ft. or 17 ft. between centers. These consist of Bethlehem H-beams with fabricated bases for taking the foundation bolts. The catenary brackets are of light angles with adjustable rod sag braces. Columns of similar design but with one bracket only are used on the single-track Blue Island branch.

With the exception of the territory between Homewood, Ill., and Matteson, where signal bridges were in service prior to the electrification, combined signal and catenary bridges are used at all signal locations. These are built with the inspection platforms on a level with the lower chord of the trusses in order, again, to minimize obstructions to the view.

All steel used in the permanent structures except the H-beams has a copper content of about 0.25 per cent. The results obtained by the use of this steel in car construction indicate a rust resisting quality which it is claimed amply warrants the additional expense. The catenary structures were erected by the railroad company's forces with a locomotive crane and work train.

Exterior of Brookdale Substation Which Is Typical of the Architectural Treatment of All I. C. Substations

Flexible Catenary System Uses Double Contact Wires and Auxiliary Messenger

With substations located approximately six miles apart along the right-of-way, no auxiliary feeders are required for the 1,500-volt d.c. system. The catenary system is so designed that it provides the necessary current-carrying capacity without additional feeders. Over each main track the catenary distribution system comprises a composite, copper and copper-clad steel, main messenger of high tensile strength, a hard drawn copper auxiliary messenger and two cadmium bronze or copper grooved contact wires. The main messenger is 0.81 in. in diameter, made up of seven high strength steel copper-clad wires surrounded by 12 hard drawn copper wires and was furnished by the Copperweld Steel Company. This cable has an equivalent conductivity of 370,000 circular mils, a normal tension of 7,700 lb. and an ultimate strength of 35,000 lb.

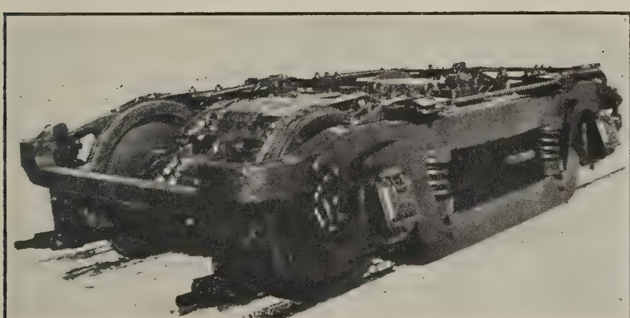
In the heavy traffic section north of 69th street bronze hangers consisting of single bolt clamps with 5/16-in. hard drawn copper hanger rods are spaced 20 ft. apart normally. Suspended from these is a 200,000 circular mil 19-strand hard drawn copper auxiliary messenger with a normal tension of 1,200 lb. Two No. 3/0 80 per cent conductivity cadmium bronze grooved contact wires are suspended from the auxiliary messenger by bronze clips spaced alternately every 10 ft. The normal tension in each of the contact wires is 2,000 lb. The bronze

clips are fitted with T-head bronze bolts and nuts permitting complete shop assembly and avoiding the necessity of starting the nuts on the bolts in the field.

In the territory south of 69th street and on the two branch lines the main messenger is the same size as in the territory north of there but the auxiliary messenger is of 105,500 circular mils area made up of 19 strands of hard drawn copper wire with a normal tension of 800 lb. Grooved contact wires are No. 4/0 hard drawn copper with a normal tension of 2,000 lb. each. The hanger and clip spacings are 15 ft. and 7½ ft. respectively. The copper equivalent of the catenary system as installed north of 69th street is 838,900 circular mils, while south of there it is 898,700 circular mils as installed new. Throughout the life of the contact wire the average conductivity over each track will be approximately 790,000 circular mils copper equivalent.

The double-contact wire arrangement here used differs from what has been used previously in other installations, for instead of suspending both wires directly from the main messenger a stranded auxiliary messenger is used which increases the flexibility of the system. In addition the individual contact wires are clipped alternately to this auxiliary messenger resulting in a "soft" line. It is recognized that this comparatively elaborate system might be prohibitive for certain installations but the electrical conductivity is required and if sufficient capacity were not installed over each track additional feeders would be needed. The distribution system provides an average voltage drop in normal rush hour service of approximately 12 per cent with an all day average of 3 per cent.

The bronze hangers and clips, as well as other catenary fittings, were furnished by the Ohio Brass Company, while the No. 3/0 cadmium bronze contact wires and the No. 4/0 hard drawn copper contact wires were supplied by the American Brass Company which also furnished the ½-in. and ⅜-in. copper auxiliary messengers.



Trucks Are of the Swing Bolster Equalized Type, the Frames with Pedestals, Transoms and Brake Supporting Lugs Being Integral Steel Castings

The Bridgeport Brass Company supplied the ⅜-inch bronze messenger wire used for yard track distribution.

The main messenger which has a sag of 4 ft. 9 in. in a normal span, is supported from the catenary structures by two 7-in. disk type Lapp suspension insulators having a minimum dry flash-over rating of 60,000 volts each. The messenger-supporting clamps are of bronze and are designed to permit the cable to slip at an unbalanced lateral stress of about 1,000 lb. They were furnished by the Ohio Brass Company. Owing to the large number of viaducts north of 43rd street, the normal height of the contact wires is 18 ft. 6 in. above the top of the rail, whereas south of 43rd street it is 22 ft. Underneath viaducts the minimum height of contact wires is 16 ft. 6 in.

Steady attachments are made to the auxiliary messenger and when one track only is adjacent to structures a pipe bracket steady arm with a standard suspension insulator and a 12-in. wood stick is used. Between the columns of catenary structures the steady assemblies are made up with a ⅜-in. high strength bronze wire cross span, using two standard suspension insulators between the tracks and structures with short steady arms attached to this cross span member. At curves the pull-offs are similar somewhat to the steady arms except that the attachments are made to both contact wires through flexible arms as well as to the auxiliary messenger.

A much simpler catenary construction is employed over the yard tracks. A ⅜-in. bronze messenger is used from which is suspended directly a single No. 4/0 hard drawn copper grooved contact wire.

Novel Construction Methods Employed for Stringing Overhead Wires

Several labor-saving ideas were developed by the contractor to expedite the construction of the overhead system. For the erection of the catenary main messenger which weighs 1½ lb. per ft., roller bearing suspension rollers were designed and attached to the bottom of the insulators in their permanent position. The bronze messenger clamps were wired immediately below the rollers, the insulators, rollers and clamps being hung from the structures at the same time. The messenger cable was run off of the reel car of the work train over a suitable pulley on top of the crane boom and was laid in the rollers at each structure as the work train passed under. The cable was sagged to exact measurement from the top of the rail by reference to temperature charts, after which the messenger was attached to the permanent supporting clamps and the rollers taken down.

The dead end and splicing fittings for the main messenger were applied in the material yards before the reels were loaded on the reel car which permitted the actual field splicing to be made in 30 min. or less. With a reel car holding five miles of wire and with eight linemen and two groundmen it was possible to install from one to five miles of main messenger in a day. The average performance, however, was slightly over one and a half miles with sufficient time to sag the messenger permanently.

The next operation was the attachment of the hangers for the support of the auxiliary messenger which hangs level 1¾ in. above the contact wires. Since the spacing of the catenary structures could not be made uniform for reasons already explained, a method of readily determining the proper length of hangers for spans of every length had to be devised. For this purpose a large board was designed having laid out on it a set of horizontally compressed catenary curves superimposed on each other and suitably cross sectioned to permit the selection of hangers of the proper length for any length of span. The hangers thus selected were assembled in the storeroom shop, arranged in proper order on a pipe and marked for the required span. This graphical method of determining the proper length of hangers was developed by J. S. Thorp, distribution engineer of the

Chicago Terminal Improvement department of the railroad.

To attach the hangers proper spacing was determined by the use of a steel tape having predetermined spacings suitable for different lengths of spans marked on one side and dimensions to facilitate centering the tape between the structures on the reverse side. This tape was stretched between the structures along the side of the messenger cable and clamped to it by the men who installed the messenger clamps. The linemen rode the messenger and placed the hangers at the points indicated on the tape, carrying a full set of hangers on their chairs.

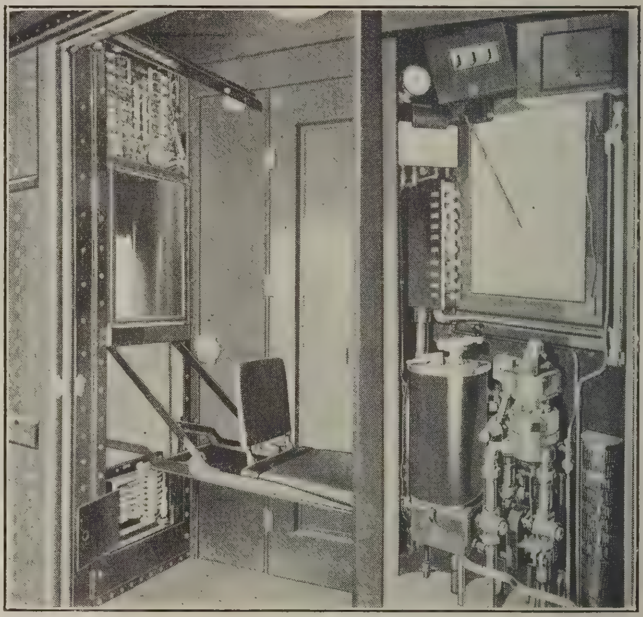
Contact Clips Were Spotted with an Elastic Gage

The auxiliary messenger and double contact wires were strung in one operation from a train consisting of an engine, reel car, tool car and tower car. Three-wheel rollers were designed to attach to the bottom of every other hanger and the wires were placed in them as the train moved along the track. After the wires were properly sagged by reference to a temperature chart and anchored, the auxiliary messenger was attached to the hangers and the clips securing the contact wires to the auxiliary messenger installed, using a work train with five or six tower cars. To obtain the proper spacing between contact wire clips, which is always half the distance between hangers irrespective of their spacing, and of necessity varying with the length of span, an ingenious application of an elastic ribbon was made. The ribbon used was about 15 ft. long and was provided with clips at the end for attachment to adjacent hangers. Two markers 7½ ft. apart and spaced symmetrically with respect to the center were attached to the elastic ribbon, thus marking, when the ribbon was stretched between hangers, the point of applying the clips without the need of making any measurements. This clipping-in process was the slowest work of all but with a train with 14 to 16 men handling the clips, about 8,000 ft. of track was completed in a day.

While the main work was handled effectively by the methods just described the cutting in of insulation, the installation of cross-overs, pull-offs, steady attachments and special work of every character had to be done without the use of any special or novel equipment and the latter constituted a large share of the entire job. The stringing of wires was started in September, 1925; although the track work was not advanced to the point where continuous effective construction activities could be maintained until January, 1926. Practically all of the overhead catenary system was strung by the middle of June, after which eight work trains were occupied with special work such as installing pull offs and making adjustments until July 20.

The overhead contact system has been sectionalized in order to minimize delays to traffic should trouble occur. This has been done at all of the substations, but to get the maximum benefit of the copper installed and to avoid excessive voltage drop it has been necessary, also, to install tie stations at intermediate points between some of the substations. These latter are located at existing or future interlocking plants or at the stub-ends of two or more tracks. Sectionalization of the main line is accomplished with air gaps, the double contact wire lending itself readily to this method At these points the contact wires are raised alternately high enough to insert strain insulators in each without any danger of the insulators fouling a pantagraph. Over slow-speed cross-overs and turnouts wood stick section breaks are provided.

The positive traction feeders to the overhead system at substations are either 1,000,000 or 1,500,000 circular mils, single conductor, 61-strand, soft drawn copper cable with 6/32-in. paper insulation and ⅛-in. lead covering. The negative feeders are 2,000,000 circular mil single conductor stranded cable with 4/32-in. paper



Left—Looking Towards Rear of Motorman's Cab with Folding Seat Extended. Right—Front of Cab with Master Controller, Air Brake Valve and Cab with Master Controller, Air Brake Valve and Auxiliary Control Box

insulation and ⅛-in. lead sheath. The latter are bussed in the manholes at the bases of the structures from which point connections are made to the impedance bonds of the different tracks by means of 1,500,000 circular mil stranded copper parkway cables, buried in the ballast. The rail return circuits are tied together with similar cables, connections being made to the neutral point of the impedance bonds.

Where possible the tie station buildings have been located so that the cables run direct from the buildings to the structures thus saving a considerable investment in underground duct systems and in cable connections. If a fault occurs on the overhead system the feeders to that particular section are opened immediately at the substation. A high speed breaker similar to the type installed in each of the traction feeders within the substations is installed in the same feeders at all of the tie stations.

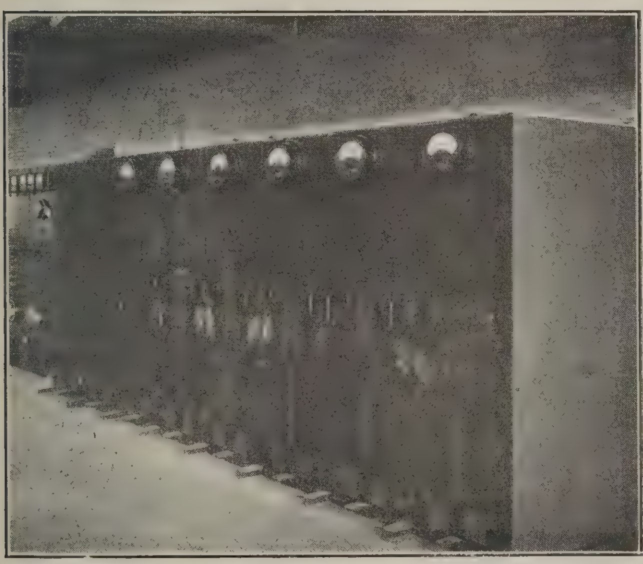
Gas Welded Bonding Used for Return System

The return system in certain places is reinforced by bonding additional tracks to those actually electrified. This has been done in the territory between 16th and 69th streets to get the required return conductivity. A single No. 4/0, 127-strand, soft drawn copper cable bond of the gas weld type, supplied by the Electric Railway Improvement Company, Cleveland, Ohio, is installed on each standard joint. The rail is 90 lb. A.R.A.

Type-A with a special reinforced angle bar. The bond when straight measures 13½ in. over-all with 8½ in. between terminals and when applied is so formed that it is approximately 7 in. between the inside ends of the terminals. Two copper terminals are provided on the bond to service the cable and provide shoulders for welding. Actually the weld is made between the outside rail head and the ends of the individual copper strands, but it also includes the copper terminals. For turnouts, slip switchs and movable point frogs, special bonds are installed made from 300,000 circular mil 127-strand soft drawn bare copper cable. These were cut in the field to the proper length and fitted with special terminals by means of tools and dies developed for the purpose. Similar methods were employed in making the connections from the impedance bonds to the rails for the traction current. The impedance bonds are provided with lugs for rail connections for the cross bonding between the tracks and also for the return circuits from the impedance bonds to the negative busses in the structure manholes at feed points.

The catenary structures are in most instances grounded to a rail in any particular track circuit, and in addition, to the neutral connection of the impedance bond wherever possible. For the structure ground a No. 1, 37-strand, parkway cable, fitted with copper terminals applied in the field is gas weld bonded to the structure and to the ball of the rail.

To obtain the benefit of the lower rate provided in the



G. E. Truck Type—JR Feeder Breakers in the East 16th Street Station

comprehensive service agreement with the Commonwealth Edison Company a miscellaneous light and power, and signal transmission system is installed. From Randolph street to 69th street the light and power transmission system consists of duplicate 4,000/2,300-volt, 3-phase, 60-cycle, 4-wire lines. For the balance of the suburban zone including the two branches a single circuit of similar description is used. The conductors are No. 1, hard drawn solid copper with triple braid weatherproof insulation and are spaced 1 ft. 9 in. horizontally. They are sagged 6 ft. in a normal span corresponding to a tension at 60 deg. F. of 600 lb. This wire was furnished by the Kerite Insulated Wire & Cable Company.

As with the catenary system the miscellaneous light and power lines are sectionalized at the substations with separate feeders for each direction. The line can be cut through any substation if service at that substation is interrupted. At points midway between substations switches have been provided also for sectionalizing purposes and permit localizing line troubles in cases of emergency. The present cross-arm arrangement on the catenary structures permits the ultimate extension of the duplicate power line south of 69th street to the Front avenue substation at Kensington (115th street).

Both light and power transformers up to 15 kw. capacity are mounted directly on the catenary structures but where greater transformer capacity is needed separate housings are provided. It is planned that at future large load centers, separate a.c. substations will be provided, these to be fed directly from the 12,000-volt system of the Edison Company. Lightning arrestors of both the auto-valve and oxide-film types and the usual fused cut-outs protect all transformers. The secondary circuits are grounded with a No. 6 hard drawn copper weather-proof wire clamped to the catenary column and connected to an independent ground rod. The service wires are carried in conduit down the catenary column to the nearest manhole or service switch.

Labor Saving Methods Used in Stringing Transmission Wires

For the stringing of the transmission wires the contractor developed several interesting labor saving devices. A bank of nine roller bearing grooved rollers placed on a common shaft 6 in. apart and secured to a channel iron was attached to the top cross arm. A train consisting of an engine, reel car, tool car, locomotive crane, material car and one tower car was used for this work in the double track territory with intermediate supports. Specially designed rollers were mounted on the top of the tool car and a cage-like device made up of vertical and horizontal pipe rollers was secured to the end of the crane boom. In this way the wires were spaced to conform to the fixed rollers through which they floated freely. A maximum of eight wires were placed in the rollers with one movement of the train. In addition to the double track territory there is on most of the right of way a track external to the bridge supports which allowed the work train to travel on that track, placing the wires in the rollers and feeding off of the reels as it moved along. With reels, each holding a mile of wire, and two reel cars, 16 wire-miles have been put in the rollers in a day and sagged temporarily. A follow-up gang sagged the wires in the rollers and tied the wires to the insulators. Wires were transferred from the top to the bottom cross arms where necessary without any difficulty.

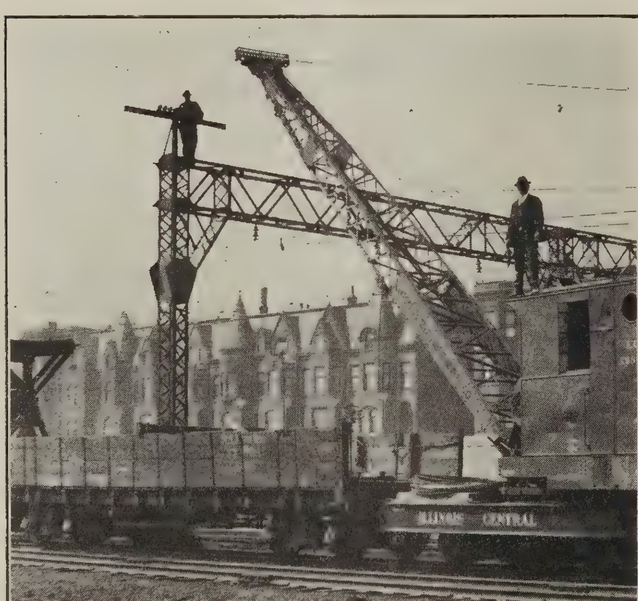
Where a track external to the catenary structures was not available a patented pulling device designed by the contractor was employed which handled as many as six wires simultaneously. In this method the reel car was anchored and the wires attached to a spreader which was pulled over the rollers by means of a heavy rope that had been run over the center rollers. Where convenient an engine was used to pull the wires through the rollers at other times this was done with a team of horses or motor truck. A maximum of 6 wires at one time were put up in this way, an average day's work

being 6 wire-miles. Except for the time required to place the rope over the center rollers on the structures this last method was almost as efficient as the operation described where an external track was available.

Motor Cars and Trailers Are Semi-Permanently Connected

It was recognized as necessary from an operating standpoint to have identical equipment for all classes of service which made it necessary that the motor car equipment selected be able to stand the maximum service without injurious overload. From this standpoint the local run to South Chicago was the determining factor. With the 20 cars purchased in 1920 for steam operation and 25 additional cars obtained two years later, all of which are now being converted into trailer cars for electric operation, there will be available shortly for suburban service 130 two-car units. The trains are made up of motor car-trailer units semi-permanently connected with one control point in the motor car and one in the rear end of the trailer, each motor car being equipped with four d.c. motors.

This selection was based upon studies that were made of the economic value of various make-ups of trains, this particular arrangement possessing advantages in both first cost and annual charges as well as other advantages of an operating nature. The new equipment provides automatic acceleration as well as manual step by step operation, a new design of automatic, mechanical electrical and pneumatic coupler, and electro-pneumatic brakes capable of applying the brakes simultaneously on all cars of the train. There is little difference in the bodies of the motor cars and trailers, except that the motor car underframe was designed to carry the control equipment and the roof framing was proportioned to carry two pantographs. While trap doors and steps were provided on the original 45 cars used in steam operation, they are omitted from the new motor cars and are installed only on the ends of trailer cars adjacent to the motor cars. Their provision is only for emergency use, as high platforms are installed at all of the suburban stations.



By Means of a Cage-Like Assembly of Pipe Rollers Secured to the End of the Crane, It was Possible to String Eight Transmission Wires at a Time

Each car of a motor car-trailer unit will seat 84 passengers, 68 in the cross seats and 16 in the four longitudinal end seats. The aisle width is 3 ft. ½ in. The cars are each 72 ft. 7½ in. long over the buffers and 10 ft. 6 in. wide over the platforms at the vestibule side doors. The body of the car is of copper-bearing steel, the inside sheathing of aluminum, the roof sheets and lower deck sheets of aluminum alloy and the doors, of which there are 11 in each car, are made of sheet aluminum. Without any passenger load the motor car weighs completely equipped 141,000 lb. and the trailer car 85,000 lb. Collapsible safety gates are provided between the cars at the sides to prevent passengers on suburban platforms falling between cars. As an added convenience all cars are equipped with diaphragms to permit easy access from car to car without exposure to the weather.

Work Train Equipment Used for Stringing Main Messenger

The motor cars were built by the Pullman Car and Manufacturing Company, while the 85 new trailers were furnished by the Standard Steel Car Company. The latter company is also converting the 45 cars formerly used in steam operation for use as trailers.

The trucks, of the swing bolster equalized type with a wheelbase of 8 ft. 3 in., are equipped with two 750-volt motors each, the latter being insulated for 1,500 volts, as the two motors are permanently connected in series on each truck. On the basis of hourly rating these motors are 250 hp. and have a continuous current-carrying capacity of 210 amp. The General Electric Company and the Westinghouse Electric & Manufacturing Company each furnished 260 motors. The truck frames with pedestals, transoms and brake-supporting lugs are integral steel castings made by the Commonwealth Steel Company, Granite City, Ill. Rolled steel wheels 38 in. in diameter are used. Clasp brakes are used on both motor and trailer trucks. The trailer car trucks have a shorter wheelbase, 6 ft. 3 in., and are fitted with 33-in. wheels, but in other respects they are similar to the motor car trucks.

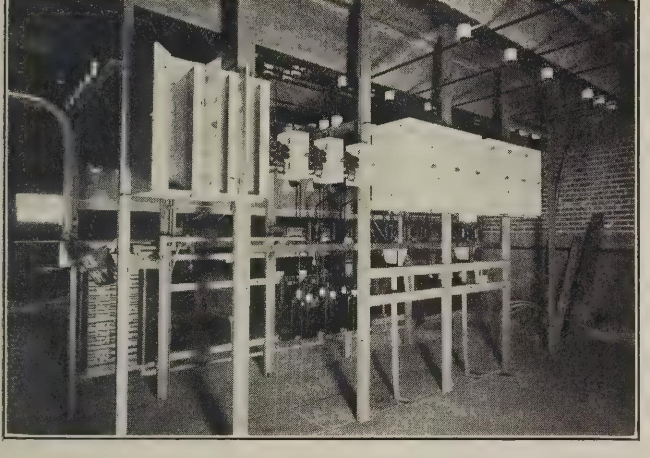
Safety First Features Incorporated in the Master Controller

The master controller has a safety-type handle which will open the main circuit and set the emergency brakes if released, except when the reverser handle is in the off position. As a further safety precaution it is interlocked with the brake apparatus in such a way that the power

cannot be applied unless the brakes are cut in service from the cab. All control equipment is G.E.-Type PC 103-D. Each motorman's control cab is provided with a door enclosing the equipment when the cab is not in use. When the door is open it forms the cab for the motorman. The space in the body bulkhead opposite the control apparatus contains a folding seat for the motorman.

The supporting structures for the two pantographs on each motor car are provided with double insulation. They have an operating range from 16 to 24 ft. and are spring-raised and air-lowered, all pantographs in a train being controlled, if desired, from a single cab. The pantographs were built by the R. D. Nuttall Company, Pittsburgh, Pa.

To provide 32-volt energy for control and accessory equipment a 3.5-kw. 1,600-volt G.E. motor-generator set is installed on the motor car. A storage battery is floated across this motor-generator set as a reserve source of energy. This unit has a double commutator and a common frame for both motor and generator. With the pantograph raised this unit runs continuously, delivering a floating charge to the 300-ampere-hour storage battery. An automatic safety regulator of the carbon pile type



Light and Power Equipment in the Basement of the Laflin Street Substation

regulates the voltage and load imposed by the control equipment connected to it, while separate carbon pile Safety regulators control the lighting circuit voltage in each car.

Each car is equipped with duplicate automatic Type-PS New York air brake equipment. At the same time that the electro-pneumatic brakes function the equipment also operates pneumatically. This permits the brakes to operate as standard automatic air brakes if the control voltage should fail for any reason without any additional attention from the motorman. While the normal service braking rate is 1.75 m.p.h. per sec. the cars can be braked in an emergency at a rate not less than 3 m.p.h. per sec. The normal brake pipe pressure is 90 lb. Each motor car is equipped with a G.E. 1,500-volt d.c. motor-driven air compressor having a piston displacement of 35 cu. ft. per min. and two 16-in. by 60-in. main reservoirs. Through a separate synchronizing train line circuit, operating at control voltage, all of the compressors in a train start when any governor cuts in, the latter having an operating range betwee 100 and 115 lb. per sq. in

Triple Connections Made with Automatic Couplers

At each end of the motor car trailer unit there is an automatic self-centering Tomlinson coupler made by the Ohio Brass Company, which completes the mechanical, pneumatic and electrical connections between the units. These are furnished with 6½-in. by 8-in. Harvey single spring friction draft gears and ball and socket anchorages. The draft gear is designed for a maximum curvature of 33 deg. The two-car unit may be coupled or uncoupled from an adjacent cab and can be operated also by hand from the ground. The automatic coupler contains the brake pipe and main reservoir balance pipe air lines and 39 contacts arranged in three rows with 13 contacts in each row for the low-voltage control circuits. Between each car of a two-car unit there is a 1,500-volt bus for the heaters only and this is hand-controlled from under the car as the motor and trailer cars will not be separated except in the shop or for emergency purposes. However, the 1,500-volt circuits are not carried through the operating units of a train.

For heating purposes, 1,500-volt, 750-watt units are provided, there being a total of 29 kw. per car. These heaters are equipped with two coils; normally one element under each of the 34 cross seats and all these underneath the longitudinal end seats may be energized. At low temperatures or when needed quickly to heat the cars, the additional coil under each cross seat may be used. Automatic control of heater circuits is provided by two thermostats of different temperature settings, subject to selection by the trainmen. The resistance units used in the heaters were supplied by the General Electric Company and the Edwin L. Wiegand Company, Pittsburgh, Pa.

The four vestibule side doors are operated by Consolidated 32-volt motor-operated door engines instead of the usual pneumatic type. The control stations for these are just outside the car end door and consist of a master switch which controls all four doors on one side of the two-car unit and a switch for the individual door adjacent to the station. The four doors can be controlled from any one of the four control switches.

Engineering and Construction Organization

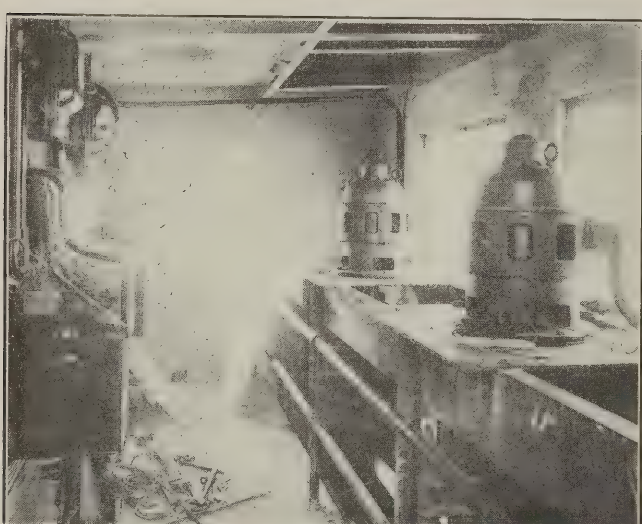
All engineering work involved in connection with this electrification project was carried out under the general supervision of F. L. Thompson, vice-president, in charge of the Chicago terminal improvements of the Illinois Central and D. J. Brumley, chief engineer. W. M. Vandersluis, electrical engineer, had direct charge of the design and construction of all electrical features of the work, assisted by G. I. Wright, office engineer, A. H. Woollen, equipment engineer, and J. S. Thorp, distribution engineer. The mechanical department co-operated in the design of the equipment, the following members being represented on a joint committee responsible for the present design: R. W. Bell, general superintendent of motive power; J. H. Nash, superintendent of motive power; W. O. Moody, mechanical engineer; E. Von Bergen, air brake engineer; Lee Robinson, shop engineer; F. H. Case and E. W. Jansen, electrical engineer. The following members of the Chicago Terminal Improvement department were members also of this joint car committee: W. M. Vandersluis, electrical engineer; A. H. Woollen, equipment engineer, and W. T. Kelly, mechanical engineer.

The foundations were installed under contract by the Underground Construction Company with M. D. Thompson, assistant engineer of the railroad in charge. The catenary structures were completed by the railroad company's forces, under F. O. Draper, supervisor of bridges. Erection of all overhead wires for traction, miscellaneous power and light and signal systems, and all rail bonding was done under contract either on a fixed price or unit basis by the Pierce Electric Company, Chicago, with S. N. Tideman in general charge of construction, assisted by Floyd Knott, general construction foreman, and J. S. Farrell, field engineer. All substation design and construction was carried out by the Commonwealth Edison Company.

Automatic Pumping Equipment for Grade Crossings

Automatic pumping stations, for the collection and disposal of storm water, were recently installed jointly by the Detroit, Toledo & Ironton Railroad and Wayne County, Michigan, for operation at seven of ten highway grade crossing separations just completed on its northern division. These stations were designed to solve the problem of adequate storm water drainage in view of the low level resulting from depressing the highway.

Concrete pump houses were erected containing electrically driven pumps operating from local power lines. Concrete sumps sunk about 15 feet below the pavement collect the water from catch basins located at intervals along the line of the depressed highways, the water being diverted underground through vitrified tile drains. Other catch basins above the pump house floors, but below railroad grade, provide receptacles for the water as it is pumped from the wells and are sufficiently elevated to allow a gravity flow through vitrified pipe into drainage ditches under the tracks.



Interior of Pump House, Showing Motors Coupled to Pumps Over the Sumps

American Well Works pumps are used at six of the crossings and all the pump houses are equipped with General Electric motor drive with automatic control. A typical installation consists of two 8-inch centrifugal pumps within the pump house which empty the 17,800-gallon sump. Each pump has a capacity of approximately 860 gallons a minute and is driven by a 10-horsepower motor having a double squirrel-cage rotor.

Float switches in the wells control the pumping motors through magnetic switches. The pumps supplement each other, one or both being thrown into action as the level of the water rises. They are automatically thrown out of service as the water recedes in the sump. Maintenance costs are reported by the railroad to be comparatively small.

A Crossing at Ecorse, Near Melvindale, Mich.

Three gigantic hydro-electric units of the Philadelphia Electric Company on the Susquehanna River at Conowingo will each have a capacity of 54,000 horsepower.

Chicago Daily News

The Pep Machine

General View of the Garage Interior at Manchester, N. Y.

Electric Trucks on the Lehigh Valley

Complete Rebuilding of Trucks Is Part of Maintenance Program Which Keeps Big Fleet in First-Class Condition

AT Manchester, N. Y., one of the largest freight transfer stations in the country is operated by the Lehigh Valley Railroad. From this transfer whole carloads are dispatched carded direct to destination, all freight received in mixed cars from originating points or other transfers. Direct destination cars are made by sorting out and consolidating the many small shipments received from hundreds of shipping points. All shipments are transferred and forwarded the same day as received. Manchester Transfer is the only transfer so located as to permit a consignee to buy goods in New York, Newark, Philadelphia, Boston, New Haven, Providence or Portland, Maine, and have them reach destination from one transfer.

The plant is of steel and concrete construction, absolutely fireproof and can accommodate 244 cars at one time. There are four island platforms 1,013 ft. long connected by a central transverse platform 39½ ft. in width. Each of the longitudinal platforms is 17½ ft. in width overall, but reduced to 15½ ft. clear roadway by reason of the posts which supports the canopy roofs located over each platform.

The transfer of large tonnage at this point requires unusual speed and efficiency and a system of paying labor is of considerable interest. Checkers, loaders, truckers and storers are guaranteed an hourly rate plus whatever they may earn in excess of the hourly rate under the tonnage system of payment. Each gang is required to handle seven tons of freight per hour or 56 tons per gang for eight hours before any bonus is paid. For all tonnage above 56 tons, the men receive a bonus.

The tonnage system of payment increases production and the Manchester transfer is an exceedingly busy place. The fact should not be overlooked, however, that in spite of the bonus system that stimulates the men, the key of the whole situation in the rapid transport of freight is a fleet of 72 load carrying electric trucks.

This fleet of industrial trucks is the vital point about which the entire activities of the plant center and the congestion which would rapidly develop should any appreciable number of these machines break down, may be readily imagined. It is, therefore, of greatest importance that all the trucks receive a maximum of care and maintenance in order that they may function dependably.

The force which is required to keep the trucks in first-class condition is not as great as might be thought. There is one machinist, one electrician and two helpers on the day force and one electrician on from 12 midnight to 8 a. m. The duties of the day force are to make the running repairs and keep the trucks in first-class order and to rebuild trucks when they are incapacitated by reason of hard wear and tear to which they are necessarily subjected.

Rebuilding Trucks

Practically all of the trucks have been in service years beyond their ordinary life, but by rebuilding them it has been found that they are capable of rendering as much service as any new truck so that the length of their life is indeterminate. When a truck has been in use to the extent that it is in need of major repairs, it is taken apart and all of the parts are cleaned and an entirely new frame is constructed following the design originated by Richard O'Hearn, foreman of the garage. Such parts as are still suitable for service are used on running repairs of trucks that have not been rebuilt.

The frame of the rebuilt truck is very much heavier

than the original frame, being constructed of heavy angle iron and it is more durable in this particular service. All movable parts such as bearings, bushings, contacts, brushes, pigtails, and wiring are renewed on this heavy frame truck and certain points are strengthened so as to prevent breaking in service. One of the important features in the rebuilt truck is a back brace made of sheet steel which serves to keep the upright apron sheet in its place and keeps the worn gussets from breaking. This sheet not only protects the back, but it also extends along under the floor boards as far as the trailer wheels and keeps them from being broken. By extending as far as the trailer wheels this sheet allows the trailer wheel bridge to rest on top of the sheet across its entire width thus eliminating the wear on the center sills and side sills. This wear is occasioned by the edge of the trailer wheel bridge cutting into the sills so that after some years of service, the truck would become weakened at this point. In the rebuilt construction, the edge of this bridge rests upon the reinforcing sheet and as the weight is distributed the wear is not nearly as great. An attempt is made to rebuild one electric truck with a heavy frame construction each month.

Showing the Manner in Which Heavy Steel Sections Are Handled

Maintenance Routine

In the general routine of maintenance the trucks are brought to the garage, taken apart and cleaned. All electric contacts are cleaned and all parts that require lubrication are greased or oiled.

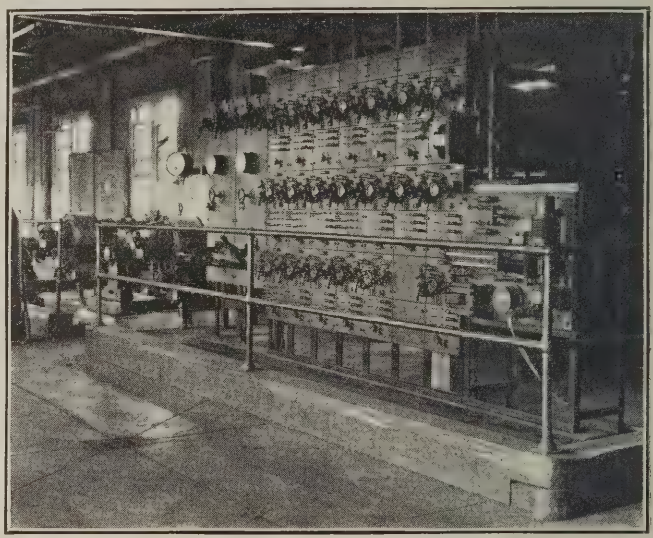
Hydrometer readings of the batteries are taken while the truck is undergoing repairs and if the gravity is below 11.50, the solution is renewed and the battery boxes and trays are repainted and the batteries cleaned up in general.

Brakes are also relined at this time and it has been found in some cases that brake liners can be used again by turning them over and using the liner from one shoe on the opposite shoe. This is very easily accomplished as the rivet holes on the lining come in exactly the right place when the linings are reversed in this manner. The practice has proved quite economical, as it is possible to get another year's wear out of the liner after this transposition has been made.

Considerable savings are effected by the use of acetylene and electric welding on the parts that have become worn. Such worn parts are welded up with metal and then turned down in small lathes with which the garage is equipped.

Charging Equipment

The battery charging equipment consists of two motor generator sets. The motors are Westinghouse 75 hp. 440 volt, 73 amperes per terminal, two phase, 60 cycle, 1,170 r.p.m. machines. The d.c. end of these units develops 440 amperes at 125 volts. These machines are connected in parallel with equalizing buses so that either machine can be used on any of the charging panels.



The Charging Switchboard Is Located in One End of the Garage—The Welding Panel Is at the Right While the Motor Generator Sets Are Shown at the Left

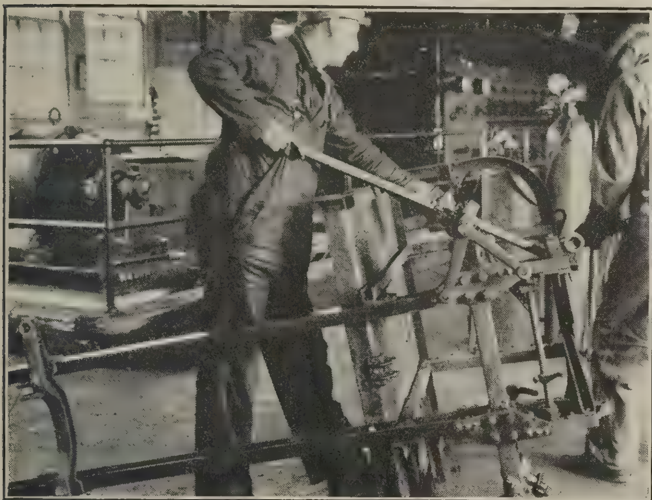
The charging panels themselves are comprised of 20 unit panels. Each unit handles three batteries and is so connected that one combination voltmeter and ammeter will take the reading of any one of the 60 batteries that may be on charge.

Taking Voltage Readings of Cells During Running Discharge Test—Battery Shaker Is Shown at the Left

At the close of the day's operation on the transfer platforms, the electric trucks are brought into the garage by the truckers and the afternoon electrician immediately opens the covers of the battery boxes and starts flushing the cells.

It usually takes about 1½ hours to get sufficient batteries watered for the first charging load. This is approximately ½ of the total number of trucks. After the batteries are put on charge, voltage readings are taken every hour and as fast as the individual sets come up to 40 volts they are taken off charge.

There are 21 cells of alkaline batteries in each set



Two Men Engaged in Rebuilding a Truck Frame Out of Heavy Angle Iron

which is charged at the rate of 45 amperes until fully charged.

Between battery readings, the first shift electrician waters the batteries of the trucks waiting to be charged.

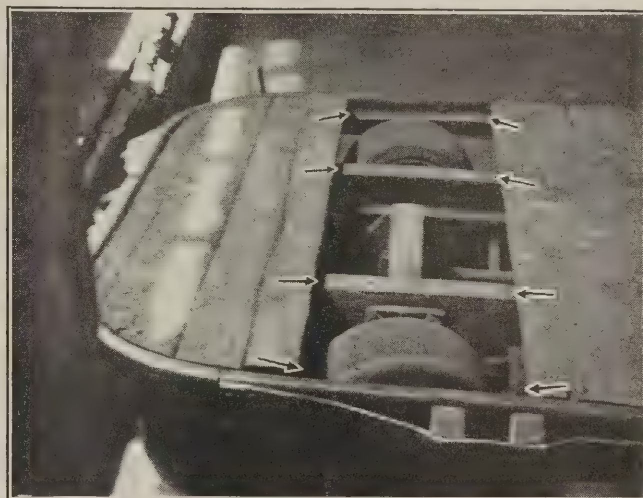
The duties of the second shift electrician are to charge the second load of the batteries, clean and renew charging plugs, repair step chains, renew broken floor boards and any other minor repairs that can be made while the trucks are in the garage.

The switches on the switchboard are connected to the charging plugs in regular order, going down one side of the garage and back up the other so that it is easy for a man to determine the switch that controls any particular plug.

The charging lines are run in a 3 in. conduit and arranged with outlet boxes at intervals, 3 plug cords coming out from each of these boxes. The plugs themselves are suspended from the ceiling with sash cord which is counterweighted so that the plugs when not in use hang within reach over a man's head. All that is necessary is to reach up for a plug, pull it down and connect it to the charging receptacle at the batteries. It has been found that by having the charging lines suspended from the ceiling in this manner the insulation on the wires will last an indefinite period. This is much better than the old method which causes the cords to be broken by the wheels of the trucks, sometimes causing fires and no end of repairs due to insulation coming off and wires grounding.

Care of Batteries

A battery shaker has been constructed using pipe fittings and pipe which is operated with a motor originally used in an interlocking plant for the operation of a switch. The battery cells are taken out of the trays and 50 per cent of the solution is poured into a receptacle. Rubber corks are inserted in the cell caps to keep the solution from coming out of the cells while in the process



Old Method of Supporting the Trailer Wheel Bridge—Arrows Point to Places Where Wear on the Sills Was Excessive

of shaking. After the cells have been shaken about 20 minutes, they are tipped side up and the corks pulled. The shaker is again put into motion and the cells are emptied. The first solution that was taken out is poured into the cells and they are again shaken. This is done in place of rinsing with water which would have a tendency to take a certain portion of the gravity of the new solution to resaturate the plates. The cells are then removed from the shaker, painted and refilled. This work is done as quickly as possible in order that the plates are not exposed to the air any longer than is necessary.

Some of the batteries which are waiting to be refilled are partly discharged by using them to operate the motor which drives the shaker. The balance of their charge is removed by connecting them to a rheostat after which

Switchboard Panels		1			2			3			4			5			6			7			8			10			11			12			13	
Bat. Nos.	20	80	65	72	33	89	2	24	78	77	60	65	61	42	56	1	38	57	3	25	68	52	39	54	79	58	18	10	49	21	64	91	13	81	29	92
6:30 P.M.	34	34	34	34	34	34	36	34	34	36	34	34	34	34	34	40	36	34	36	36	40	38	38	40	36	34	34	34	34	34	34	36	34	34	34	34
7:30	36	36	36	36	40	36	38	38	38	38	38	36	36	36	36	42	38	36	38	38	42	40	40	42	38	38	38	36	36	36	36	36	36	36	36	36
8:30	38	38	38	38	42	38	42	40	40	40	40	38	38	38	38	44	40	40	40	40	44	42	42	44	40	40	40	38	38	38	38	38	38	38	38	38
9:30	40	40	40	40	44	40	44	42	42	42	42	40	40	40	40	44	42	42	42	42	44	44	44	44	42	42	42	40	40	40	40	40	40	40	40	40
10:30	42	42	42	x	x	x	x	x	x	44	44	42	42	42	42	44	44	44	44	44	44	44	44	44	x	x	x	x	x	x	42	42	42	42	42	42
11:30	44	44	44	x	x	x	x	x	x	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	x	x	x	x	x	x	44	44	44	44	44	44

Record Showing Hourly Voltage—Readings of the Batteries on Charge Taken at the Various Panels

the battery is short circuited and allowed to remain on short circuit over night so that there is absolutely no chance of heating the plates while being exposed to the air.

All connectors and battery binding posts are thoroughly cleaned with fine sand paper and the circuits are tested by a heavy current discharge for a few minutes to determine any loose connections which would immediately become apparent by overheating. In this way any hot connections which might develop while the batteries are in service are avoided.

After the cells have been thoroughly shaken, cleaned and filled with new solution, they are charged for 12 hours and discharged for 6 hours. This process is repeated three times, that is to say, the batteries are given three cycles of charge and discharge.

At the end of the third six hour discharge, the battery is brought to a completely discharged condition and again charged for 12 hours. This usually equalizes all of the cells, but if any cell or cells are low in capacity they are removed and replaced with high capacity cells. The low capacity cells are then treated by giving them a heavy charge and discharge for several cycles which in most cases brings their capacity up to standard. If this operation is not effective due to some internal defect in the cells, they are then returned to the factory for repairs.

The Reinforcing Sheet Indicated by the Man in the Picture Has Been Applied to Nearly All of the Trucks

Nothing but distilled water is used to flush the batteries and a small still with a capacity of about five gallons per hour is located in one end of the garage not far from the place where the shaking and refilling of the cells is done. This still is operated by steam which is derived from a steam boiler located in a small building adjacent to the garage. The water that is used for cooling the still is run into a reservoir and is used over again in the boiler. Steam from this boiler is also useful in cleaning trucks and bearings as well as cleaning tops of batteries.

When cleaning battery tops and pulling trays out, any foreign matter which might work down between the cells is removed. This eliminates the possibility of short circuits between cells which may result in the cells becoming punctured.

Records

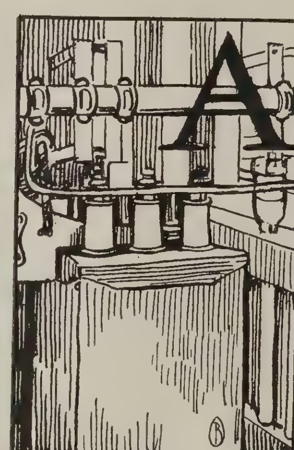
A detail record of repair parts is kept, showing the date used, number of parts, and the part number and cost. This is totaled up at the end of the month and gives the total cost of the garage operation, showing the cost of truck material, cost of battery material, cost of current used for charging batteries and cost of labor for charging the batteries and repairs to trucks.

A card index in which each battery is represented by a card is used to keep the record of the cleaning of the tops of the batteries. The index is worked by taking the front card off each time a set of battery tops is cleaned and placing the card in the back of the file. The aim is to go over the tops every four months, and by rotating the cards as described, this is accomplished. Sometimes, two or three sets will be cleaned in one day and then a day or two may be skipped.

For checking up on the greasing periods, a large blackboard is installed in the garage which bears the truck number and the battery number and the last date that the truck was in the garage for first-class greasing and cleaning. In this way each truck receives proper attention at regular intervals and experience has shown that the method works admirably.

Installation and Maintenance of Oil Circuit Breakers*

By H. J. Pfandhoefer
General Electric Company



AN OIL CIRCUIT BREAKER is the value for the outlet or intake of generated electrical energy, and if not properly installed or maintained, stops the production of power or taking in of power. It is, therefore, extremely essential that it be properly installed, and after installation that it receive proper care, just the same as any main steam valve or water valve.

Oil circuit breakers when operating under short circuit must open many times the normal generating capacity of a system, due to the fact that when a short circuit occurs on a system the current value rises greatly and this higher current value must be broken at the time of trouble. Therefore, the term "interrupting capacity." Therefore, installation and maintenance of an oil circuit breaker is just as important, or more so than a good many other pieces of electrical apparatus.

The following are points to be borne in mind when an oil circuit breaker is being installed and points on how the breaker should be maintained after installation.

Installation

1. With all oil circuit breakers shipped by manufacturers there are given complete instructions for the in-

* Delivered as a talk before a meeting of the Operators of the Minnesota Power & Light System, March 23, 1926.

stallation of the breaker. Follow these instructions carefully and to the letter.

2. After installation carefully check all moving parts to see that they function properly and freely, and that all bearings run free.

3. Check studs and be sure that they are properly tightened in place.

4. Inspect contacts for alignment to make sure that they all seat properly, that they do not bind, and that all contacts make and break at the same instant.

5. Be sure that tanks are full of proper oil and filled to the proper level, and that the oil is clean and dry.

6. Oil all moving parts on the mechanism thoroughly before attempting to put the breaker in service.

7. The breaker should now be ready for trial. Always try the breaker by hand first whether manual or electrical, and be sure that the breaker is dead before this trial is made.

8. If breaker is electrically operated and all of the above points prove satisfactory and breaker operates satisfactorily by hand, then try electrical operation with the breaker still disconnected from the line. Do not try electrical operation with the tanks off. The tanks should be in place so that the additional effect of the contacts travelling through the oil is obtained. If trial is made with tanks off there is also some danger of injury to the breaker due to the lack of cushion caused by the contacts traveling in oil.

9. You are now ready to make connections to the breaker, and when these connections are made be sure that they are tight and of ample size, otherwise if this is not the case heating may develop in the breaker and the breaker be held responsible for this heating, when as a matter of fact, the trouble is in the connections and being communicated from them to the breaker.

10. Be sure the breaker frame is thoroughly grounded.

11. The breaker is now ready for service and should go on the line without any further trouble, provided everything has been taken care of as outlined above.

A Few Don'ts

1. Don't install a breaker in a dead air pocket. All electrical apparatus must have changing air, and a breaker is a piece of electrical apparatus. I have seen many cases where breakers installed in dead air pockets have heated unduly simply due to the fact that there was no changing air, with the resultant fact that the heat continually built-up pyramided, and the breaker was held at fault when simply a small circulation of air was all that was needed.

2. Don't guess. Your guess may be wrong and cause a shutdown, which of course means a loss of revenue and a dissatisfied customer. If you do not know, find someone that does or look up your instructions on that particular breaker and find out.

3. Don't expect an indoor breaker to withstand the elements such as it may have to do when installed in a wet room or by a window which may be left open during storms.

4. Don't install out of alignment. If a breaker is not properly aligned at the time of installation some time when that breaker should operate automatically parts may bind when there is the greatest need for the breaker to open.

5. Don't install a breaker too small in ampere carrying or in interrupting capacity and expect it to function properly on your system. In the first case you will get heating; in the second case trouble will develop in case the breaker is called upon to operate under short circuit.

Inspection

After an oil circuit breaker is in operation see that this breaker receives proper and periodical inspection. Every breaker should be inspected at regular intervals about every three months. It should also receive inspection after it has opened under a severe short circuit. Some power companies are even going so far on inspection that a breaker is inspected after every operation even under normal conditions. This latter applies to stations in the Super-Power Class. A regular inspection should include the following.

A. Cleaning of all parts including oil.

B. The oiling of all moving parts with particular reference to the mechanisms whether these mechanisms are solenoid or manually operated.

C. Check contacts and make sure that they seat properly; clean and realign if necessary.

D. See that all connections to and from the breaker are tight and are not causing undue heating.

E. Check all mechanisms whether manually or electrically operated and make sure that they operate properly. In checking mechanisms, this is to include the checking of trip coils so that in case the breaker is called upon to operate automatically the trip coils are in proper condition to open the breaker.

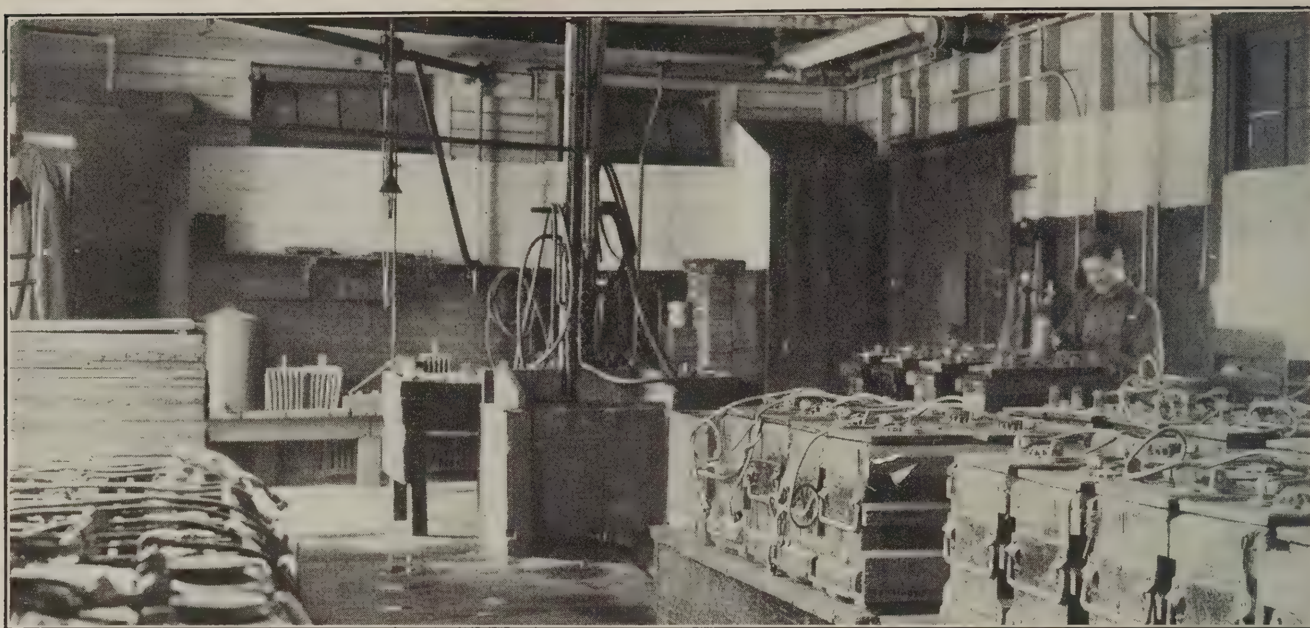
F. Check the ground connection to the breaker.

G. All of the above instructions under the subject of inspection relate to periodical inspection. If a severe short has been taken by a breaker it should be inspected completely as soon as possible thereafter. In making the inspection after the breaker has opened a short circuit, also in the course of regular inspection, look for weakened or broken parts and replace if necessary.

It is advisable to have a complete supply of spare parts on hand for those parts of the breakers such as contacts which are most apt to burn out or give trouble.

It would seem from the above that an oil circuit breaker is a piece of apparatus that needs continual or extra care. I do not wish this idea to be conveyed at all. What I do wish to convey is that an oil circuit breaker is apt to be looked upon as a piece of apparatus to be installed and forgotten, due to the fact that there are no rotating parts to call the operator's attention to the fact that it is a piece of electrical apparatus. Therefore, an oil circuit breaker, the same as any other piece of electrical apparatus, should receive ordinary care, so that the best results may be obtained from it. We would not think of allowing a turbine to run year in and year out without periodical inspection, or at least putting some oil in the bearings. If we give the same care to an oil circuit breaker that we would ordinarily give to a piece of rotating apparatus, I am sure that we will find that the oil circuit breaker will be very grateful, and in turn give us excellent service, and operate properly as the valve for the sending out or taking in of power.

The Chicago & Eastern Illinois, in conjunction with the Missouri Pacific, has inaugurated a daily package car service between Chicago and Memphis, Tenn. The car leaves Chicago at midnight and arrives at Memphis at 3 p. m. on the second day, thus affording third morning delivery.



Corner of the Battery Room at the Kansas City Terminal

Carlighting Practice at Kansas City Terminal

Unique Methods of Inter-Communication Prevents Congestion and Expedites Movement of Cars

By W. J. Dawson
Chief Electrician, Kansas City Terminal Ry. Co.

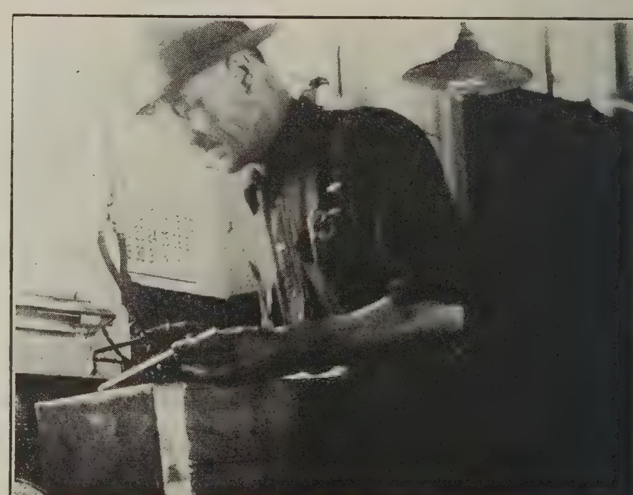
THE article published in the March, 1926, issue of the *Railway Electrical Engineer* generalized on the maintenance practices, forms used in making records and reports, and the methods of accounting employed in the car-lighting department of the Kansas City Terminal Railway Company. This article will describe more in detail the facilities and equipment in use.

The coach yard is divided into north and south yards by main line tracks, and "high-line" structure, serving Union Station traffic to and from the West and North. This necessitates electrical shops in each of the yards, and the work is arranged as nearly as possible so that the men assigned to work on trains in one yard are not called on to go to the other yard more than is absolutely necessary. This reduces, to a minimum, the delays and hazards incidental to crossing the main line tracks.

The shop in the south yard is considered the main one and is housed in the main service building of the yard. The space provided is a one-story frame, 112 feet by 30 feet, and is partitioned off into three rooms, namely: the battery shop, repair shop and battery charging generator and switchboard room. Wash room and locker space for the men is provided in a separate room of the service building.

Battery Room Equipment

The battery room has benches on either side and a double-width bench in the center which accommodates twelve sets of batteries. The benches are built to the height of the average battery box floor from the ground, and a wagon of the same height is used in moving the batteries in the shop, or hauling them to the cars in the yard. The usual acid mixing vats, washing bench,



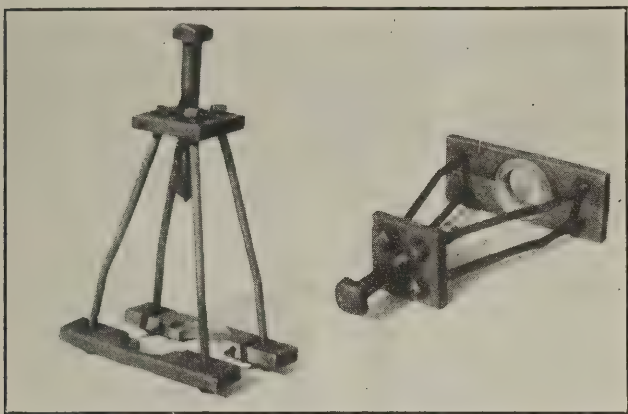
The Lead Tanks Are Thoroughly Cleaned and Worked Over by the Lead Burner Before Being Replaced in Service

swinging jib crane, water still, group press, tank washing vat and lead burner's work bench are provided.

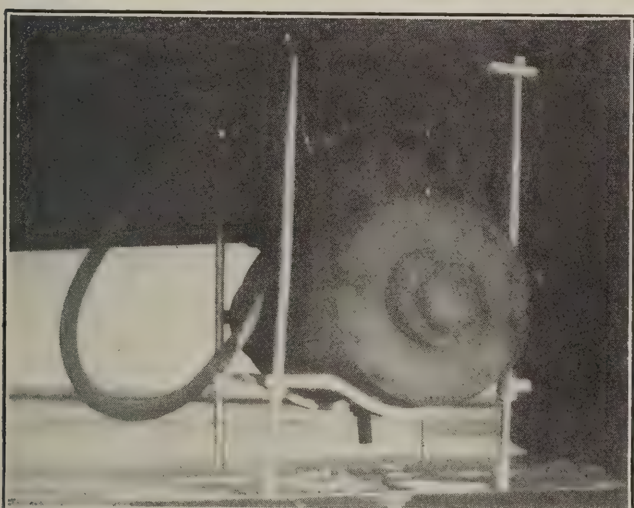
Maintenance Methods

Recommended practices for overhauling batteries are in effect. After heating the battery covers and sealing

compound with a steam jet, the covers are removed. The elements are then lifted from the tanks by use of the jib crane and insulated hooks that fit under the cross straps and swung to the washing bench. The separators are then removed and the groups are washed with a light spray of water. The negative groups are kept submerged in water or acid to prevent heating until such time as the whole set is dismantled and ready for reassembling. The tanks are then emptied of acid and placed upside down over the tank washing vat and the "mud" is washed out. This vat consists essentially of a lead lined box 40 in. by 27 in. and 32 in. high. Two pieces of ¾ in. round iron are placed transversely at the top of the vat to support the trays and two pieces of ½ in. pipe are "T'd" across under these supports and upturned with elbows and nipples at points about the center of the tanks or jars. The water supply is controlled by a globe valve within easy reach, the "mud" falling to the bottom of the vat. A drain is located near the top which prevents the sediment from getting into the sewer system and at the same time saving it for salvage.



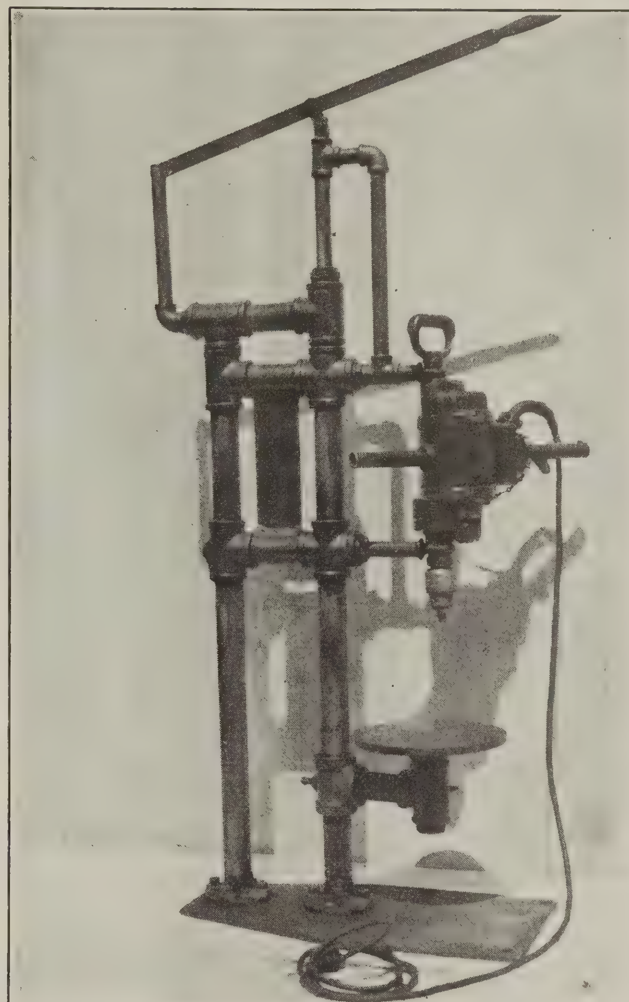
Two Views of Bearing Puller Used to Remove Pulley and Bearing from Safety Underframe Armatures Without Necessitating Removal of the Shaft from the Armature



Showing Cradle Hangers Used Instead of Blocking to Suspend Body Hung Generators While Replacing Worn Suspension Parts

The lead tanks are removed from the trays, cleaned and inspected for pitting caused by electrolysis, worked over by the lead burner and painted with acid-resisting paint. It is felt considerable economy, from cost and service standpoints, is affected through this particular handling. The trays are closely inspected and, if judged to be in fit condition to stand up in service for another washing period, they are again used. Otherwise, new trays of our own manufacture are used. Before using the old trays, they are thoroughly cleaned with steam and air of all acid and sulphate, especially from the bottoms of the compartments. After this has been done the trays are painted.

The batteries are assembled, charged and discharged, acid equalized in the cells and given the usual capacity tests before being sealed, connectors spot-burned to posts, trays again painted and stencilled ready for being placed in service.



Bench Drill Press Made Up of a Portable Electric Drill and Pipe Fittings—Provision is Made for Easy Removal of the Motor from the Stand for Portability

Electrical Energy for Water Distillation

Distilled water for use in mixing acid and flushing batteries in the yards is manufactured by use of two Barnstead Still & Sterilizer Company type E L, 220 volt electric stills, having a combined capacity of seven gallons of distilled water per hour. Electric stills are used in preference to the steam operated stills because of economy, due to the fact we manufacture our own power at a very low cost.

The two stills pull a load of 10 kilowatts and are sup-

plied with power through two transformers of 15 kva. capacity each, connected in multiple. These transformers also serve the yard pole lighting system with a load of approximately 25 kilowatts, and in order to insure against overloading them to a dangerous point, by operating the stills and yard lights at the same time, a unique method of safety is employed.

Economy in Electrical Control

Two Industrial Controller Company class 8502, 220 volt, A. C. magnetic "across-the-line" contactors, of 75 ampere and 150 ampere capacity, are inserted in the still and yard lighting circuits, respectively. The pole light contactor, normally open with deenergized shunt coil, is controlled by a push button in the Coach Yard Foreman's office. The water still contactor, normally closed with energized shunt coil, is controlled by a contacting device actuated by movement of the armature of the pole light contactor. In other words, the two contactors are electrically and mechanically interlocked so that only one of them is in circuit at a time.

This arrangement keeps the still circuits "hot" during

The Charging Outlets Are Mounted on Concrete Piers—No. 4 A. W. G. Extra Flexible Mining Type Cable, Finished Round Without Braid Has Given Excellent Results for Charging Service

non-burning hours of the pole lights, and permits hand operation of the water stills through means of The Cutter Company "U-Re-Lite" circuit breakers. Ample still capacity provides a reserve supply of water sufficient to take care of our flushing needs during the night.

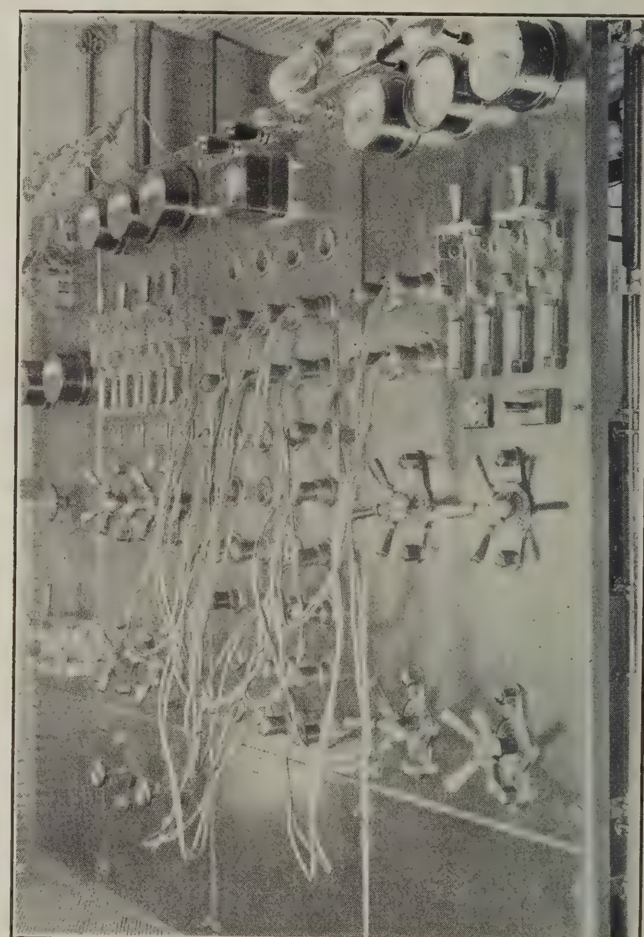
Repair Facilities and Charging Equipment

The repair shop facilities consist essentially of work bench, vises, drill press, emery wheel, armature press, pulley racks, tool lockers, tool box racks and accessories incidental to the maintenance of car-lighting equipments.

The battery charging equipment consists of a General Electric Company motor-generator set of 50 kilowatt capacity, 2300-220/110 volts, feeding a four panel switchboard. The panel on the left, for generator control, is equipped with an I-T-E circuit breaker of 300-ampere capacity, model 24 Weston meters, field rheostat and a three-pole main switch. Apparatus on the balance of the board consists mainly of six 100-ampere fused switches, Allen Bradley carbon pile and General Electric Company grid resistors, ammeter transfer switches, model 24 Weston meters, Foxboro Company, switchboard type, eight-day clock, ground detectors and receptacles connected to twelve charging circuits. A Sangamo, type N F, ampere-hour meter is mounted for use in connection with bench tests in the battery room. Albert and J. M. Anderson Company type G, No. 1764, receptacles are standard and used with type A, No. 1229, plugs and jumpers to connect the power and rheostat receptacles with the circuit receptacles.

Yard Circuits

The yards are wired with ten charging circuits having a total of sixty-seven outlets arranged with six and seven outlets per circuit connected in series, No. 4 A. W. G., lead covered and steel taped, "Parkway" cable is laid in



A View of the Battery Charging Switchboard

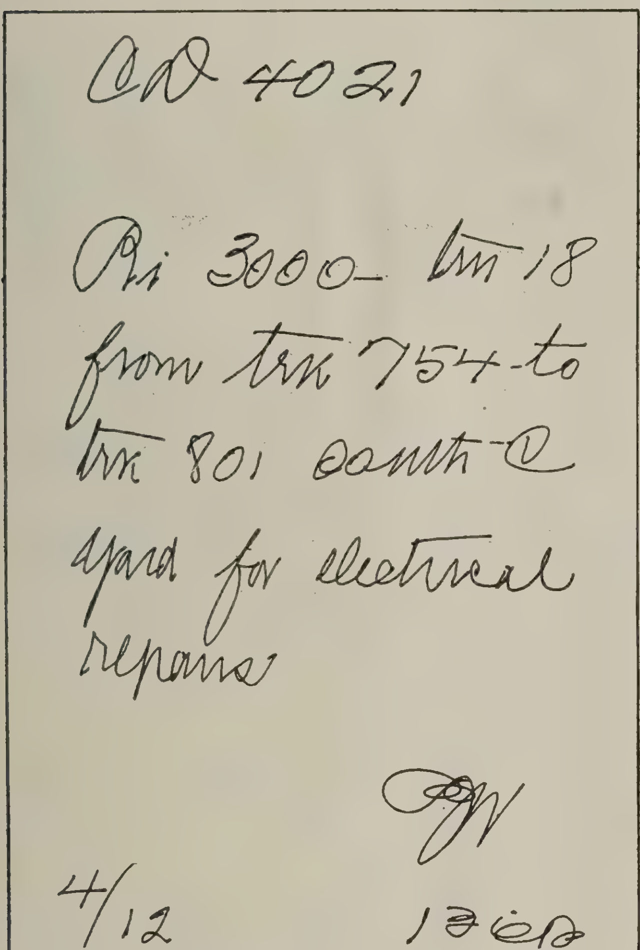
the center of twelve inches of sand at a depth of about eighteen inches. The lead sheaths of the cables are permanently grounded at the switchboard and also at the ends of the circuit loops. Lead sleeves were wiped on at all underground splices and the sheath ends were bonded together at the opening in the cables at the charging outlets to complete the sheath grounding. This was done with view of protection against electrolysis.

The charging outlets are Anderson type R, No. 1942, receptacles mounted on concrete piers. The "Parkway" cables are connected to the receptacles through internal openings in the piers. Number 2241 plugs are used to "short circuit" the receptacles when not in use. Anderson type C, No. 1967, plugs and No. 4 A. W. G.; du-

plex cable of mining type, finished round and without braid, is used for portable charging cables.

The possibility of tying up as many as eighteen tracks at one time with charging cable blue flags necessitates prompt handling in the removal of the cables and flags to facilitate switching and reduce delays from this source. All regular movements of equipment and pulling of trains for advance setting at the Union Station are done on schedule, and all charging cables and blue flags are removed from the cars in advance of scheduled time.

There is, however, a great volume of switching to do that cannot be scheduled or foreseen, such as setting


OD 4021

Ri 3000— trk 18
from trk 754-to
trk 801 South-C
yard for electrical
repairs

4/12

The Telautograph Is An Important Factor in the Handling of Equipment

cars in or out of the different trains, moving "bad orders" to the drop pits, making "cuts" or "spotting" cars for different classes of repairs, etc.

Communication

To speed up the handling in these cases, an electro-pneumatic signal whistle and a series of calls for the different foremen and battery charging men has been worked out which is giving very satisfactory results.

The whistle consists essentially of a one-half inch Crane Company whistle valve connected by means of a link to the core of a 110-volt solenoid magnet and an Aermore automobile type, four-tone, exhaust horn mounted in a weatherproof box on a pole in the center of the yard. The whistle is operated by an oil-immersed high-voltage push button in the Coach Yard Foreman's office. We found it necessary to operate the push button contacts in oil due to the arc caused by the "unloading" of the coil.

Automatic telephones are located in all of the Terminal offices and at vantage points throughout the yards, and all inter-department communication is carried on over these phones. This feature alone is an inestimable time and step saver.

The Terminal telegraph office can be termed the clearing point for orders from the various tenant lines, covering equipment movements. The orders, as received from the tenant lines, are put out to all departments over telautograph machines. These machines are located throughout the Union Station, signal interlocking towers, yards and in offices directly concerned with train and car movements.

All movements of bad order cars to the drop pits, or repair tracks, are handled on telephone call to the telegraph office and subsequent telautograph order. These orders are put out over the Superintendent's signature, dated, timed, and numbered serially.

Once a bad order "movement" is placed against a particular car, the car is tied-up and can not move in an outbound train until the defect is repaired and the second telautograph order is put out releasing the car for service.

A book record is maintained of the time the cars are set, O.K'd and pulled, and this iron-clad understanding and handling, between the departments concerned, aids materially in speeding up switching of cars for repairs or other work and definitely places responsibility for any misunderstanding, failure to place the car properly or hold it out of service for extensive repairs.

Diesel-Electric Locomotive Built in Russia

A DIESEL-ELECTRIC locomotive weighing 198 tons, including fuel and water, driven by a 1,000 h.p. engine has recently been built and placed in service in Russia. The locomotive has 10 driving and two guiding axles. The engine used is a Vickers engine built in 1916, which was taken from a dismantled submarine boat. It is a four cycle, non-reversible, 10 cylinder engine with a rating of 1,030 hp. at 395 r.p.m., without an air compressor, using solar oil with mechanical atomizing. The engine drives two "Volt's" generators, each having a continuous rating of 380 volts and 1,500 amperes. At starting and low speeds these generators are connected in parallel and at higher speeds they are connected in series. There are 10 traction motors, permanently connected in parallel, spring mounted at one end, each one being geared to a driving axle through gears having a ratio of 1 to 4.625. The motors are self-ventilated and have a one-piece steel frame with armatures mounted on S.K.F. roller bearings. The motors were built in Russia by the Electric Works formerly known as Deka. The locomotive is used to haul an 1,100-ton train at speeds up to 31 miles an hour and is designed to operate at a maximum speed of 47 miles an hour.

The generating apparatus is located in the single cab. The frame consists of two longitudinal riveted girders

35.5 in. in height at the center. The engine is installed on cast steel cross pieces and the generators are supported directly by bed girders. These girders are provided on the outside with cast brackets which support tanks for 7.7 tons of fuel oil and 1.1 ton of lubricating oil and a 600-ampere hour, 10-volt storage battery. The engine is started by using one of the generators as a motor and the battery is also used for lighting and for the operation of auxiliary motors and control apparatus.

In two diametrically opposite corners over the floor, are two cisterns of cooling water of 1.65 tons capacity each and in the other two corners are a centrifugal circulating pump, a motor driven compressor for the Westinghouse brakes and a boiler for supplying steam heat for the locomotive during long stops. There is a superstructure on the roof of the cab in which are located radiators having a surface of about 7,500 square feet. Air is drawn in through the radiators by fans driven from the engine through a belt and spur gearing. There are operating compartments at both ends of the cab.

The running gear consists of three trucks, the center truck having four driving axles and each of the end trucks having three driving axles and one guiding axle.

The 1000-hp. Diesel Electric Locomotive in Passenger Service

The frame is raised 17¾ in. over the trucks, thus leaving an open space for access to the motors, and is supported by 12 springs; four for each truck. The trucks are interconnected by rigid couplings so that tractive force is not transmitted through the cab frame.

The locomotive was designed by and built under the supervision of Prof. J. M. Haekel.

Coil Dipping and Draining Stand

The Southern Pacific Finds This Apparatus Useful in the Manufacture and Repair of Numerous Small Coils

By Niels Hansen

Assistant Foreman Electrician, Southern Pacific Railway, Oakland, Cal.

THE stand pictured in the photograph is used for dipping small rewound fan and headlight generator armatures, various types of axle generator armature and field coils and any other coils that may be necessary, in insulating baking varnish. It is also used for hanging these coils up so that the surplus varnish will drain off and run back into the dipping tank. The stand serves as a storage rack for hanging up coils that have been baked and are waiting to be taped or for coils that are all ready to be applied to the jobs which they were made or repaired for. This dipping stand was designed several years ago by the writer to eliminate a lot of mess which usually accompanies the dipping operation, to reduce the waste in varnish to a minimum and to provide a suitable place for hanging a number of sets of finished coils. These ideas were incorporated in the one piece of apparatus.

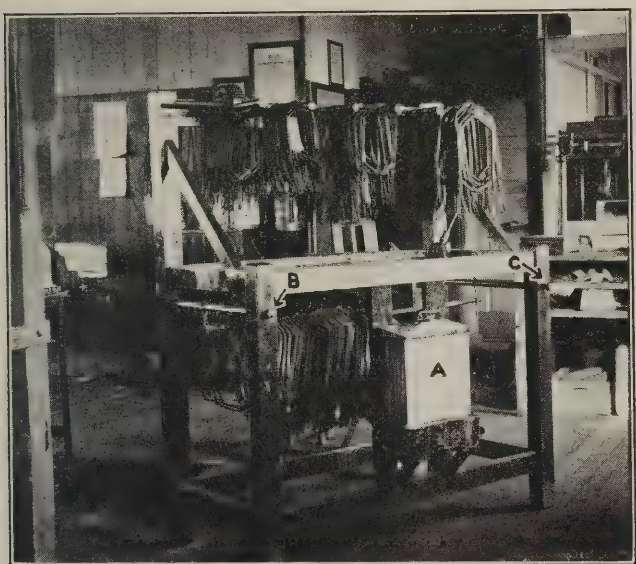
One of the principal features of the stand is the dipping tank (indicated by *A* in the photograph). This tank is made of galvanized iron and is deep and narrow so it will hold a minimum amount of varnish, but still sufficient to completely immerse any of the coils mentioned above. It is located in the center of the stand directly in front of it and low enough so that the surplus varnish which drips off the wet coils onto the drain table will run down a drain pipe back into the dipping tank near the top. A ½ in. faucet is located on the right hand side of the tank at the bottom for drawing off any varnish when desired. A tight fitting cover with a handle reduces the evaporation of the varnish solvent to a minimum.

The drain table is another feature of the stand. This takes in the full length and width of the stand and is made out of galvanized iron with the four sides sloping down to a point in the center 4½ in. below the top edges. At this lowest point is a ⅞ in. hole to which is con-

nected a piece of lead pipe running into the top part of the tank. Unfortunately these parts do not show up very well in the picture.

Another feature is the coil supports or hangers located just above the drain table. These are six in number, made out of ¾ in. pipe extending out a distance nearly equal to the width of the table. They are spaced 8 in. apart and project through the back of the stand sufficiently to be clamped in place with a washer and locknut in front and back of each one. Additional adjustable hangers are provided in back of the stand by having a piece of ¾ in. round iron rod 31 in. long placed in each of the six ¾ in. pipe coil hangers from the back which can be pulled out to any length desired up to about 24 in.

Still another feature are two additional hangers for coils located at *B* and *C*. These are ¾ in. round iron rods 25 in. long fitted with a ½ in. pipe cap as a handle



This Stand Greatly Facilitates the Varnishing of Small Coils

on the front end of each one to pull it out with when needed. Each of the rods slide into pieces of ¾ in. pipe which pass through one front leg of the stand and half way through the back legs. The hangers are conveniently located near the dipping tank and are pulled out and used for hanging up coils which are about to be dipped. Normally they are pushed back out of the way as shown in the photograph.

A small round can made of galvanized iron 8 in. in diameter and 6 in. deep equipped with two handles is used in connection with the dipping stand for dipping rewound Pyle types K, E2 and C armatures. A cover with a handle on is placed over this can when not in use.

The overall height of the stand is 65 in., length 54 in., and width 27 in., or 31¼ in. including the tank. The top edge of the drain table is 40 in. above the floor. The four legs are made of 3 in. by 3 in. pine, the front ones being 41 in. high and the back one 65 in. high. The four horizontal pieces supporting the drain table and joining the four legs are 1½ in. by 3 in. pine as are also the other four horizontal pieces near the bottom of the stand. The former are 37 in. above the floor and the latter 6 in. above the floor at the bottom edges. The joints are all glued mortise and tenon joints which make a rigid stand without bracing. Joining the two back legs near the top, 20 in. above the edge of the drain table is a long piece of 2 in. by 4 in. pine. This also has a mortise and tenon joint where it joins on to the legs. The four inch side is set vertically. Six holes spaced 8 in. apart are bored through this piece just large enough for the ¾ in. pipe coil hangers to pass through. These hangers extend out 16½ in. including the ¾ in. pipe cap on the end of each one. Two 45 deg. angle braces of 1½ in. by 2 in. pine brace the back of the stand, one on each end to counteract the strain from a heavy load of coils. The outer ends of these braces extend out horizontally and vertically 18 in. from the back and top of drain table respectively.

The dipping tank is made out of galvanized iron 12 in. long, 5 in. wide and 16¼ in. high. The cover to this tank is pyramid shaped 1 in. higher in the center than the edges which project about ⅛ in. beyond the tank. A handle on the cover permits it to be removed easily. The tank sets in a shallow framework of wood 4 in. deep fastened to the front of the stand in the center on two vertical pieces of 1 in. by 3½ in. pine jointing the two front 1½ in. by 3 in. horizontal pieces of the stand on the inside. The bottom of the tank is 14 in. above the floor and the top about 10 in. below the top of the drain table thus allowing the excess varnish to drain back into the tank at a point 1½ in. below the top edge.

The centers of the two coil supports *B* and *C* are 34½ in. above the floor. The space under the stand is also utilized to store completed coils by means of a piece of ¾ in. pipe 54 in. long hung from the supports *B* and *C*. This can be plainly seen in the photograph.

The tank is kept full of Ajax clear elastic baking varnish. The coils are dipped in this, allowed to drain and then put into an electric bake oven for about 8 hours at a temperature of about 212 deg. Fahrenheit.

This dipping stand is a very convenient piece of shop apparatus and is used more or less every day. It is located close to our electric bake oven another piece of home-made apparatus which will be described in a later article.

Rail Bonding on the D. T. & I.

One of the major operations in the construction of the D. T. & I. electrified section between Fordson and Flat Rock, Michigan, has been the bonding of the tracks. The track rails are used to carry the return propulsion current, and also the current for the signaling track circuits.

The propulsion current must be afforded a continuous return path through the rails from any part of the electrified track to the source of power.

For block signaling the tracks must be sectionalized and the various track circuits, or sections, insulated from each other, so they may function separately. Standard insulated rail joints, as used on both steam and electric roads in signal territory, are in use on the electrified section for this purpose.

Under normal conditions the maximum capacity required per rail in the return circuit is 150 amperes, the trolley potential being 23,000 volts. Each rail in each track section between Fordson and Flat Rock has been connected to the one adjoining by bond wires.

For bonding plain joints a 1-0 single stranded copper

arc weld rail bond 7½ inches long, with steel "L" head terminals welded to the ball of the rail on the outside of the joint, has been used. The steel terminals are pressed on to the ends of the short lengths of stranded copper wire when the bond is manufactured, and when welded to the rail the terminals are welded to the bond wire with the one operation.

All bonds around diamonds, switch points, or frogs, where long leads of special length are required, are of 4-0 stranded copper. They are cut to the proper lengths and the terminals are brazed onto them by the welding crew before applying the bonds to the rails. The terminals of these bonds are welded to the base instead of the ball of the rail, because the bond must be stapled to the tops of the ties, or, if very long, must be buried beneath the tracks. They are larger than the "L" head bonds, so their mechanical strength will be sufficient to withstand the treatment when track is tamped or ties are changed.

At rail crossings the bonds are of sufficient length to carry both signaling and propulsion currents from a point just outside the insulated joints on one side of the crossing to a point just outside the insulated joints on the opposite side of the crossing. For such bonding 4-0 stranded Parkway cable, buried beneath the tracks, is used.

Welding Bonds on the D. T. & I.

Where insulated joints are installed to cut the track into sections for signaling, impedance bonds are placed in the center of the track between the ties and connected to the rails with 4-0 stranded copper jumpers of the required special lengths. These impedance bonds contain a winding which forms a continuous path around the insulated joints for the 25-cycle alternating current used for propulsion while impeding from one track circuit to the other the flow of 60-cycle alternating current used for signaling, confining the flow of that current to the one track circuit.

At all locations where electrified tracks are extended beyond signal territory, as in sidings or at yard limits, single impedance bonds are placed at the insulated joints. At rail crossings, which must be insulated from track circuits but have a connection with the propulsion current rail return, single impedance bonds are placed on the side of the crossing nearest the source of power. In all cases other than these double impedance bonds have been used.

A welding crew composed of foreman, trainman to act as pilot, a welding operator, and a tractor operator who also acts as helper, weld the bonds to the rails. Before welding, a portion of the rail about to be welded is cleaned with a steel brush. The helper then holds the bond in place with a length of wood while the welding operator fills in the weld between the bond terminal and the rail, using a metallic electrode ⅛ inch in diameter. The weld is then strengthened and finished with a 5/32 inch metallic electrode. The current flow required for the weld is about 150 amperes. With no interruptions an average of nine "L" head bonds are applied to the rail each hour.

A Fordson tractor equipped with welding generator and flanged wheels supplies the power for arc-welding the bonds and carries the crew and equipment along the tracks.

The generator, with a capacity of from 300 to 400 amperes at 45 volts, together with the necessary stabilizers, exciters, and control switch, is attached to the rear of the tractor and housed in steel sheeting. The generator is driven at a speed of 1,800 revolutions per minute by the tractor engine which is equipped with a governor to control the generation.

An unusual feature about the use of the tractor is the ease with which it may be placed in the clear for passing trains. It is merely necessary to run to the nearest road crossing and with a turn of the steering wheel the operator may guide the tractor onto the road in the clear of the tracks. When the train has passed, the tractor is again driven onto the tracks and returned to the location of the work.

A trailer, a larry car covered with canvas, carries bonds, tools, first-aid equipment, and extra clothing, and protects the workmen from the weather. As a safety precaution the canvas and car are painted red as a signal to approaching trains.

The New Board of Mediation

Standing, Left to Right: Hywel Davies, Carl Williams.
Sitting: E. P. Morrow, Samuel Winslow, G. W. W Hanger

New York Central Applies Train Stop Equipment

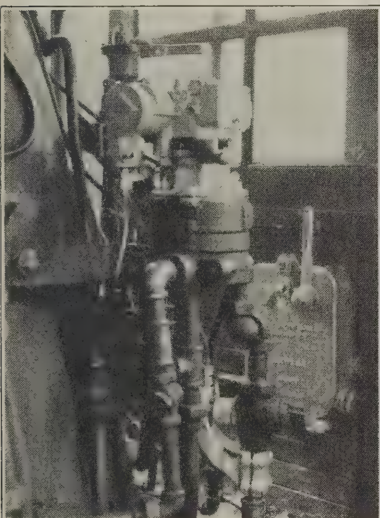
Locomotive Taken From Service Fully Equipped, Ready for Service in an Average of 93.7 Man Hours

IN order to comply with the order of the Interstate Commerce Commission and equip the locomotives operating between Buffalo, N. Y., and Cleveland, Ohio, before July 15, 1926, it was necessary for the New York Central to organize the work of equipping these locomotives with the General Railway Signal Company's intermittent inductive auto-manual train stop equipment so that the job could be handled on what may be termed a production basis. Altogether it was necessary to equip a total of 373 locomotives with this type of equipment and the work was so organized that 288 of these locomotives were assigned to be equipped at the Collinwood shops, Cleveland, Ohio, and the remaining 85 at the Elkhart, Ind., shops. After sufficient material had been received to insure the continuity of the program the work was started and the first locomotive was completed on February 6, 1926. At the time the information for this article was secured a total of 212 locomotives had been completely equipped at the Collinwood shops and the information given here pertains to the manner in which the job was handled at this point.

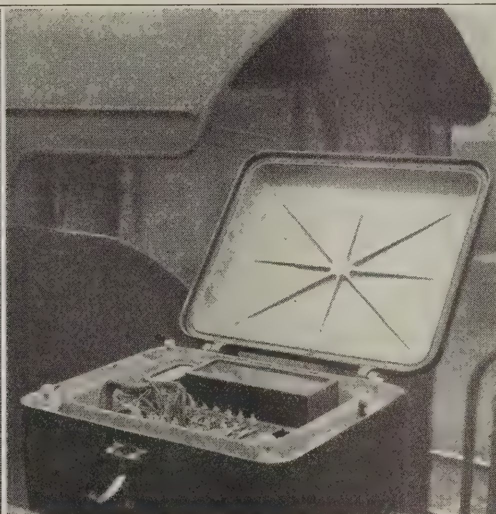
To date an average of approximately four locomotives have been equipped per day. The application of this apparatus to these locomotives is handled in two ways: as they may pass through the shop for general repairs, and by their being withdrawn from service and sent to the shops for the express purpose of equipping them with the train stop apparatus. Inasmuch as the time element is relatively less important on the locomotives which are being scheduled through the shops for classified repairs, this article deals more specifically with the manner in which the work has been handled on locomotives withdrawn from service.

As a general thing it has been necessary to hold a locomotive out of service only about 33 hours in order to apply the train control apparatus. A certain number of locomotives are delivered to the shop early in the morning of each working day so that it is possible for them to be taken into the shop some time before noon of that day. These locomotives are returned to the enginehouse completely equipped with train control apparatus and ready for service at about 4 p. m. on the following day.

Inasmuch as this work involves operations which had not been done previously, it was necessary at first to make some re-arrangement of shop forces until the most effective way of handling the work was found. Four pits in the erecting shop were set aside to be occupied solely by the locomotives being equipped. At the present time the work on these locomotives requires approximately 94 man-hours, which is about 25 per cent less than was required to equip the first few locomotives. This reduction in time may be attributed to the improvement in the organization of the forces and to the increasing familiarity of the men with the work.



Engineman's Valve Actuator



Mechanism Case on Top of Tank Cistern

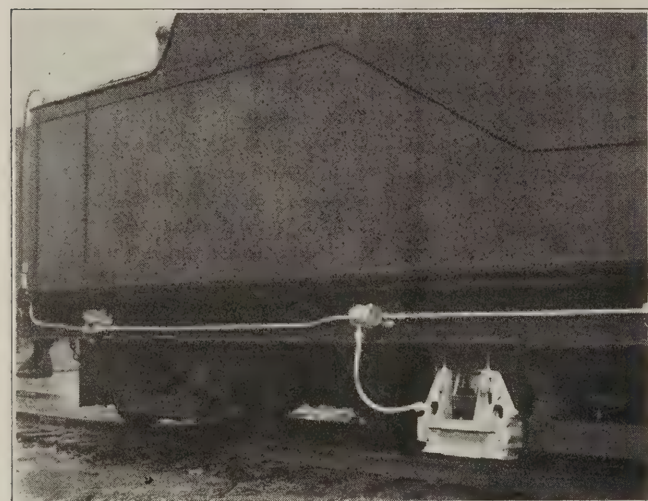
Terminal Box on Rear of Tank

Various Small Jobs Included in the Installation

The equipping of the locomotives with this type of train control equipment involves the changing of the headlight generator to provide a generator of greater capacity. The particular locomotives involved in this application of train control were each equipped previously with a 500-watt turbo-generator which was replaced with one of 750-watt capacity. In addition a double bracket has to be attached to the boiler inside the cab on which the electro-pneumatic and whistle valves are mounted. A forestalling contactor is mounted on the cab side within easy reach of the engineman and the actuator is applied on the automatic brake valve. The brake valve piping is changed slightly

and the double heading valve is now located directly beneath the automatic brake valve. A fuse connecting box and terminal box are mounted on the front of the cab. A plug coupler is mounted on the rear end of the engine, on what is known as the cab bracket or tail sheet. A similar plug coupler is mounted on the front end of the tender frame and these together with the plug connector provide the electrical connection between the engine and the tender.

The rear journal box on the right front tender truck must be changed so as to provide for the application of a special journal box with lugs on which the receiver is mounted. A plug coupler and reset contactor together with the necessary conduit are mounted on the side of the tender frame. A plug coupler connection provides the electrical connection between the coupler on the tender frame and the receiver on the tender truck. A terminal box is mounted on the rear of the tender and the mechanism box is located on the top of the tank cistern.



The Receiver Is Mounted on the Rear Journal Box of the Right Front Tender Truck

Work Is Divided Into Three Shifts

In order to handle the necessary work properly within the somewhat limited time, it has been necessary to divide it among men on three shifts. The first shift goes on at 4 p. m. and works until midnight; the second from midnight until 8 a. m. and the third from 8 a. m. to 4 p. m. Following is a brief outline of the work handled by the men on the above shifts:

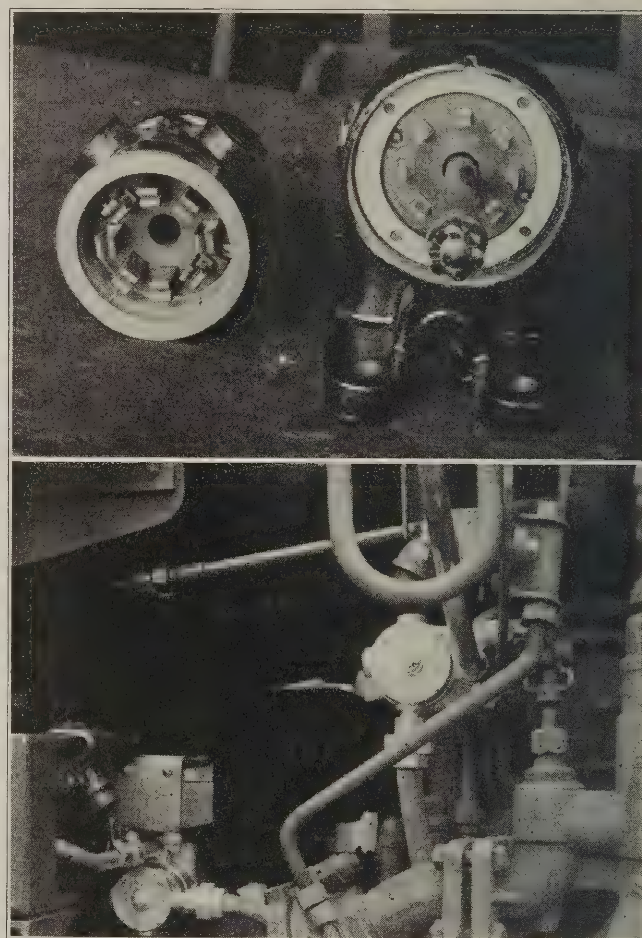
First Shift—Laying out work for application of train control conduits in cab and on tender frame, drilling holes and applying brackets on tender frame. Changing the truck journal boxes, drilling holes in cab and applying brackets for valves, changing hand rails for train control and re-wiring, fitting up receivers and couplers and testing out equipment.

Second Shift—Applying brackets on the tender, applying electro-pneumatic valves and changing generators, applying conduits on tender for train control, changing conduit on tender for headlight equipment, applying conduits in cab for train control, changing conduits in cab for headlight equipment and re-wiring, piping train control and making alterations in cab.

Third Shift—Wiring tender and cab for train control and re-wiring tender for headlight equipment.

These locomotives are delivered to the shop early in the morning and are taken into the shop at about 11:30 a. m., where they are ready for the electrical men at 4 p. m. The electrical application work is completed and the engine ready to leave the shop the next morning at 8 a. m. for testing. Finally they are ready for delivery to the enginehouse for service at 4 p. m. From the above it can be seen why the 4 p. m. to midnight shift is considered the first shift as far as the electrical workers are concerned. A total of 93.7 man-hours is required to complete all of the work.

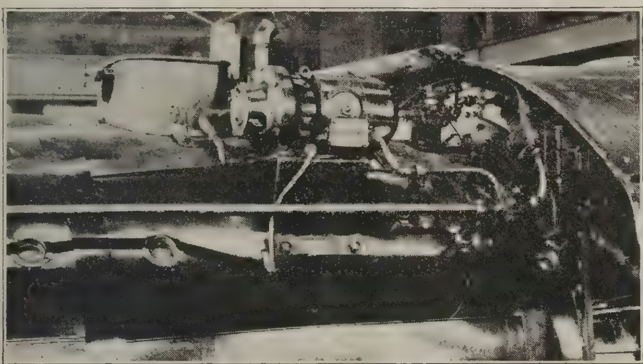
A study of the following list of operations shows that the time required is about equally divided between electrical and mechanical work:



Top—An 8-Way Plug Connector
Bottom—Plug Connectors and Cable Between Engine and Tender

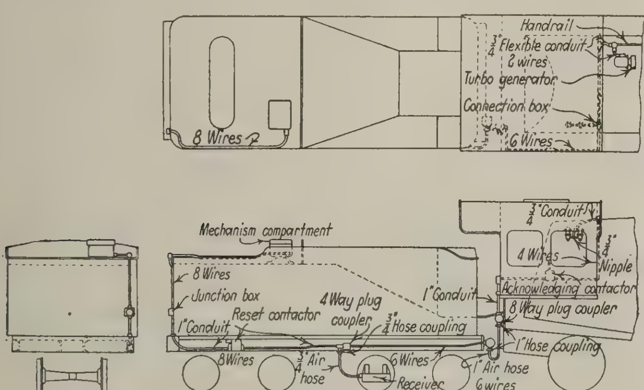
Operation	Hours.	Man-Hours.
1—Electro-pneumatic valve and whistle valve. Apply studs in boiler; apply double bracket; mount valves on bracket. 1 machinist	1.5	1.5
2—Remove old headlight generator; apply new headlight generator. 1 electrician	1.0	1.0
3—Drill holes in cab and cab bracket for plug coupler, forestalling contactor, fuse box, terminal box and conduit clamps. 1 machinist and 1 helper	2.0	4.0
4—Apply actuator on brake valve. 1 machinist	0.7	0.7

Operation	Hours.	Man-Hours.
5—Apply bracket for plug coupler on front tender end sill; apply receiver plug coupler on side of tender frame; apply reset contactor on side of tender frame; apply reinforcing plate on back of cistern for terminal box; apply reinforcing plate on top of tank cistern for mechanism box; apply mechanism box. 2 tank repairmen and 1 helper	4.0	12.0
6—Application of conduit in cab. 1 electrician and 1 helper	6.0	12.0
7—Application of wiring in cab. 1 electrician and 1 helper	3.75	7.5
8—Application of conduit on tender. 1 electrician and 1 helper	6.5	13.0
9—Application of wiring on tender. 1 electrician and 1 helper	6.0	12.0



Train Control Locomotives Each Required a 750-Watt Turbo-Generator

Operation	Hours.	Man-Hours.
10—Making up plug coupler connection between engine and tender. 1 electrician	2.0	2.0
11—Making up and applying receiver connection 1 electrician	2.5	2.5
12—Changing tender truck journal box. 1 truck repairman and 1 truck repairman helper	1.5	3.0
13—Applying receiver. 1 electrician	0.5	0.5
14—Changing automatic brake valve piping and piping up electro-pneumatic valve. 1 pipe fitter and 1 helper	4.0	8.0
15—Testing electrical features of train control equipment. 1 electrician and 1 helper	2.0	4.0



Layout Plan Showing Location of Conduit and Various Parts of Train Stop Equipment

Operation	Hours.	Man-Hours.
16—Testing mechanical features of train control equipment. 1 air brake inspector, 2 pipe fitters and 1 air brake machinist	2.0	8.0
17—Making up tags for marking circuits. 1 set for each locomotive—(94 tags.) 1 electrician	2.0	2.0

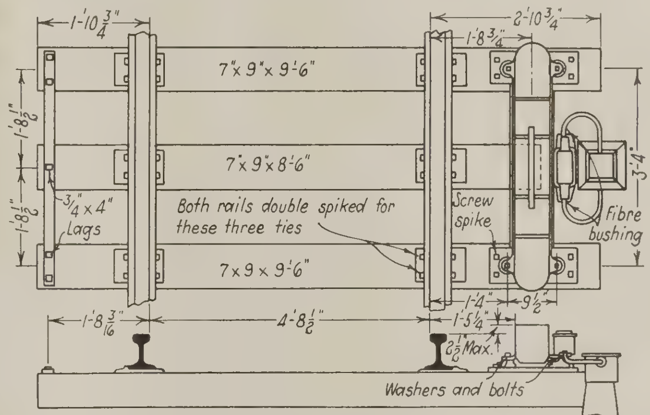
Installation of Wayside Inductors

In connection with this installation of intermittent auto-manual train stop equipment it was necessary to install 665 wound inductors and 4 unwound inductors in the 174 miles of territory between Bay View, 8 miles west of Buffalo, N. Y., and Cleveland, Ohio. Inasmuch as the division between the lines east and the lines west is made at a point approximately 8 miles west of Buffalo station, the number of inductors given above and other references to the installation of way-side equipment refer to that portion of the territory starting from this point to Cleveland.

The train stop apparatus has been installed on all four tracks; namely, east and west bound, high and slow speed tracks respectively in the above mentioned territory. At each point where inductors are installed it was necessary to replace at least two ties of the normal 8 ft. 6 in. lengths with two ties having a length of 9 ft. 6 in. The work of installing ties was started early in April, 1926, and the work of installing inductors was started during the same month.

In the 120 miles of 4-track territory between Bay View, N. Y., and Ashtabula, Ohio, it was necessary to change the automatic signal circuits. Between Ashtabula and Cleveland, a distance of 54 miles, no change of circuits was necessary.

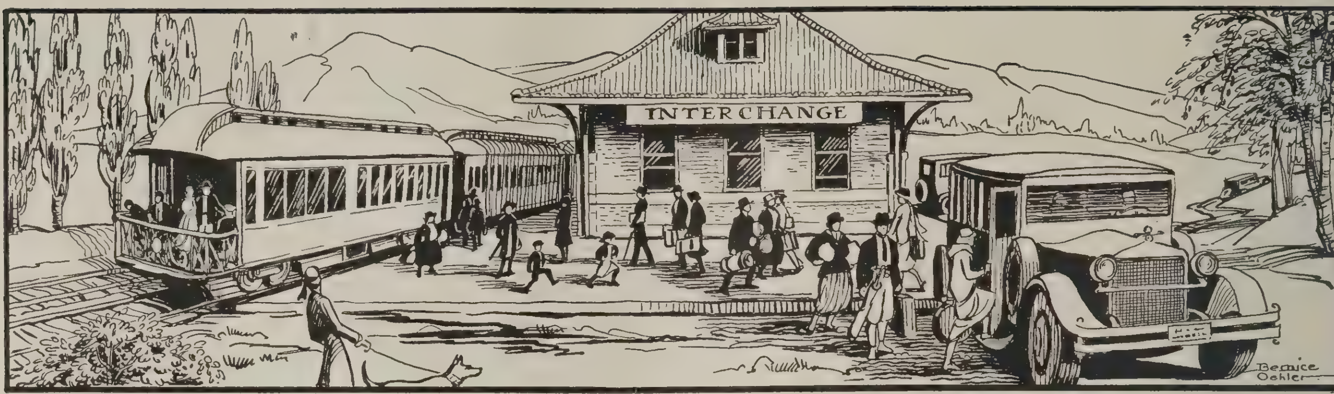
Aside from the regular men employed in the signal



Plan of Wayside Inductor Showing Method of Making Parkway Cable Connections

department, a special gang of 20 men was assigned to the job of changing the signal circuits in the 120 miles of territory mentioned. The work of changing the circuits started about February, 1926. The inductors were placed in part by regular signal maintenance men in conjunction with regular signal repair gangs as they happened to be in the territory where the installation of train stop equipment was being made.

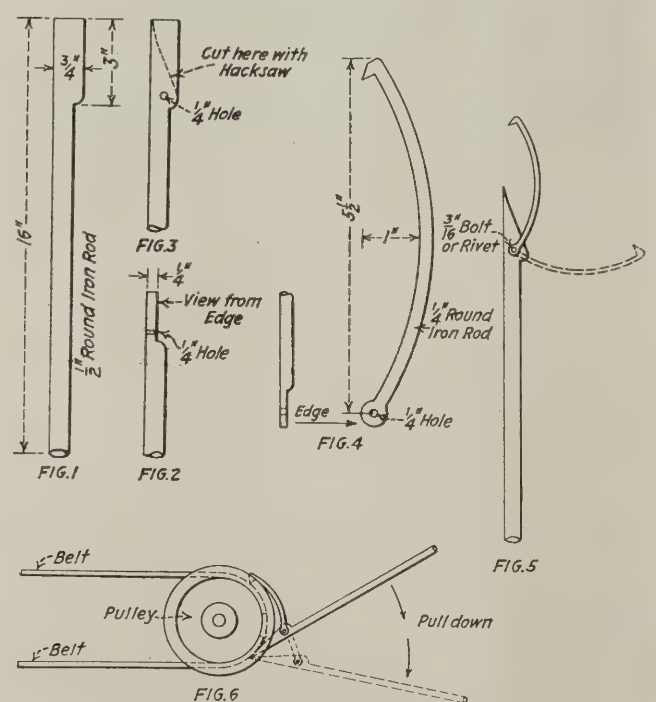
The trenching for parkway cable was handled by three gangs under the supervision of the maintenance of way department and the cable was laid by signal department men working with the trenching gang. The work of laying the No. 8 lead sheath parkway cable, consisting of 19 strands of No. 21 A. W. G. wire, was started in March, 1926. The sketch shows how the cable was run from the inductors. A square concrete post was embedded in the ground alongside of the track. This concrete post has a conduit cast in it into which the cable enters underground and passes up through the concrete post and into a cast iron terminal box mounted on top of the post which is above the ground level. Two separate cables, each with an approximate length of 70 ft., run from the signal to the inductor.



A Handy Belt Stretcher

By B. A. Daniels

As I am a car lighting electrician and have to replace a large number of belts on generators of axle lighting equipment, I have found that at times I would get a belt a little short, so that it would be necessary for me to use a belt stretcher. This stretcher which was furnished me by the company had four prongs and in using it con-



Construction Details of a Simple and Convenient Belt Stretcher

siderable time was consumed. As it is necessary to make every minute count while working on a limited train, I set about to design a belt stretcher that could be applied more quickly. After some figuring I finally constructed the one shown in the sketches. It can be made up by any one by following the directions given here.

Take a ½ in. round iron rod, 16 in. long and measure off 3 in. from one end and center punch so that the mark can readily be found after heating. Put the rod in a good fire until red hot and hammer out as in Fig. 1 and Fig. 2. Then put it in water until cooled off, after which it should be marked and cut with a hack saw. A ¼ in. hole is next drilled as shown in Fig. 3. Then take a piece of ¼ in. round iron rod and heat one end so that there can be a ¼ in. hole drilled in the same end. Heat the other end of this piece and shape and bend it as shown in Fig. 4. File the upper end to a point and next fasten the two parts together with a 3/16 in. stove bolt or rivet and the stretcher is completed and ready for use. In our particular case Crescent belt clamps and rivets are used for putting the belt together.

An Inexpensive Lamp Post

There is a certain satisfaction that is derived from making use of material which is apparently suitable for nothing but the scrap pile and as the illustration shows, it is sometimes quite possible to manufacture useful objects that are ornamental as well.

The photograph shows two lamp posts located at the top of a stairway near the Acca Terminal of the Richmond, Fredericksburg & Potomac Railroad at Richmond,

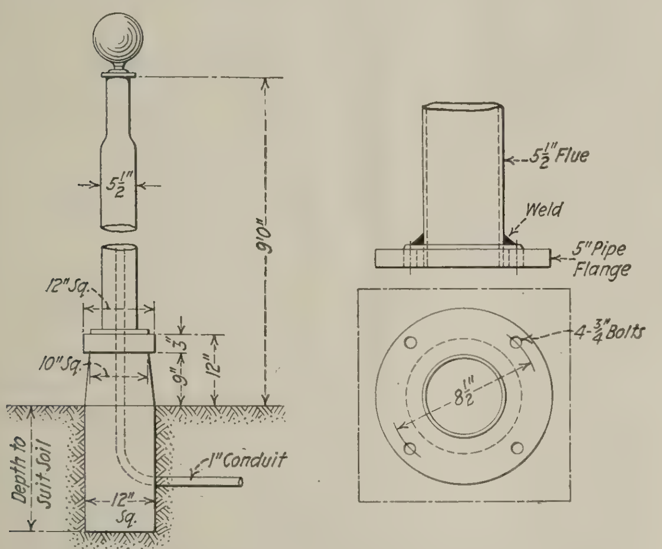
These Neat Looking Lamp Posts Were Made From Discarded Superheater Flues

Va. The posts are pleasing in appearance and at the same time serve to perform the function of lamp posts just as well as a most expensive post that can be purchased.

The posts are made out of nothing more or less than old superheater flues which are no longer suitable for

use in their original capacity. A 5 in. pipe flange is welded to the large end of the tube and four bolts secure this flange to a concrete base. Provision is made during the placing of the concrete for a 1 in. underground conduit entrance through which wires are led to the outlet at the top of the pole. In this particular case spherical opal glass globes are used. The details for securing these globes to the top of the pole are not shown but it is relatively a simple matter, and subject to some variation according to the ideas of the individual constructor. The poles are approximately 9 ft. in height from the surface of the ground to the base of the globe, although this is also subject to some variation.

The concrete block to which the flange of the pole is



Dimensional Sketch Showing Construction of the Posts

bolted may be made with plain edges and square corners or may be made ornamental to some degree. In any event, however, care should be taken to have the base to the concrete block sufficiently deep in the soil so that the frost will not cause the base to heave and throw the pole out of plumb.

When the job is completed the result is a neat looking lamp post, much of the material in which would otherwise have had nothing but scrap value and the builder feels that he has obtained something that is good and at the same time inexpensive.

What Counts

It isn't the job we intend to do,
Or the labor we've just begun,
That puts us right on the ledger sheet;
It's the work we have really done.
Our credit is built on the things we do,
Our debit on things we shirk;
The man who totals the biggest plus
Is the one who completes his work.

A Safe Place

Fugitive: "Quick! Where can I hide? The police are after me."

Office Employee: "In the filing cabinet. Nobody can ever find anything there."

Let's Lend a Hand

In the prehistoric, pagan days,
When mankind was a pup,
He was pursued, by brutes, real rude,
Who loved to "Eat him Up."
He skinned his knees, in shinning trees,
And some of *"him"* escaped;
But anxious claws and hungry jaws
His breech-clout often scraped.
Life was a race, a fearsome chase,
With dangers close behind;
To stub one's toe, or "yump" too slow—
Meant some big mammal dined;
But mankind grew and lived it through
While the slower hulks all died;
Which proves that speed is what we need
To save our worthless hide.

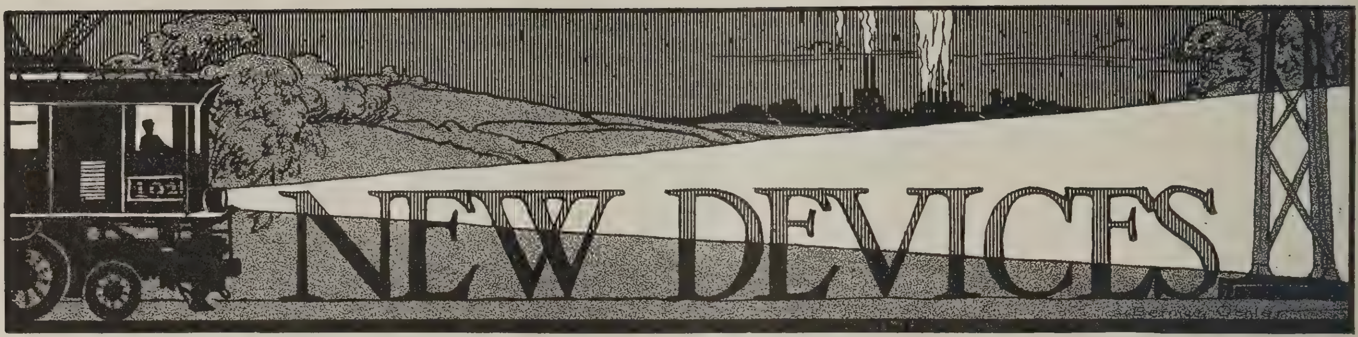
Life's still a race, a high-gear chase,
With "Wolves" and *"things"* behind,
But the hungry breed, whom laggards feed
Is their own kith and kind.
The ones who won't or can't, or don't
Soon feel a weighty paw,
And their remains (their meager gains)
Slides down some hungry maw.
So if you feel, at your lagging heel
Some panting, hairy ape—
You may succeed, by bursts of speed,
In making your escape;
And those who've won, keep on the run,
Chased by a Vicious Urge,
To scatter jack, to hell and back,
In one continual splurge.
Each bony shin still loses skin
As they climb towards the top;
They fear the wrath of the Primrose Path,
So none of *them* can stop.

You must shake a leg, or stop and beg,
That much is up to you;
But don't go wild, or get "hard-biled"
With acts that are taboo;
Because that goal beyond our Knoll
That *Ignorance* calls *"Success"*
Is but a word, all vague and blurred,
And its value is a guess.
Although our creed is based on speed,
Let's wear a healthy grin,
For soon enough the stuff that's rough
Gets in beneath our skin;
And when some Goof with blistering hoof
Is limping 'long the road,
Let's understand, let's lend a hand,
And help him lug his load.

How Come Tomorrow?

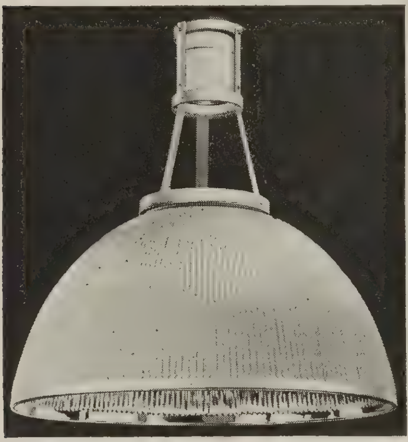
Dispatcher—What does this mean? Someone just called up and said that you were sick in bed and would not report for your run today.

Trainman—Ha, ha. The joke's on him. He wasn't supposed to call up until tomorrow.



Industrial Reflector for High Mounting

A new type of silver plated glass reflector designed for industrial service where high mounting is required is now being manufactured by the Pittsburgh Reflector Company, Pittsburgh, Pa. The reflector which is known as No. 1-1000 is designed particularly to meet the existing conditions of high industrial interiors where the lighting unit must be from 25 to 50 feet or more above the floor, usually above the crane as well; and for lighting through skylights. For these purposes; silver plated glass is the most efficient when shaped into practicable reflector contours. The reflector is very concentrating, the bulk of the reflected light being confined to the zone 0 to 40 degrees. The 5 in. open neck and holder permits approximately 5 per cent of the light flux from the lamp to escape to the ceiling. The maximum percentage of the reflected light flux reaches the work plane directly without striking the walls.



The Unit is Designed for Mounting at Heights of From 25 to 50 Feet Above the Floor

In the past a few large interiors have been effectively illuminated by means of artificial lighting through skylights. For this purpose, the highly concentrating reflector No. 1-1000 is effective.

For uniform illumination over the horizontal work plant in industrial lighting, the spacing between reflectors should not exceed their height above the work plane. They should not be installed at elevations less than 25 feet for the 1,000 watt lamp and 20 feet for the 750 watt lamp.

There is furnished with the reflector a porcelain mogul socket equipped with special casting at top, tapped for ½ in. conduit hanger and equipped with a special safety holder. Socket and holder are both supported from the casting, thus relieving the socket and electrical connections from any strain.

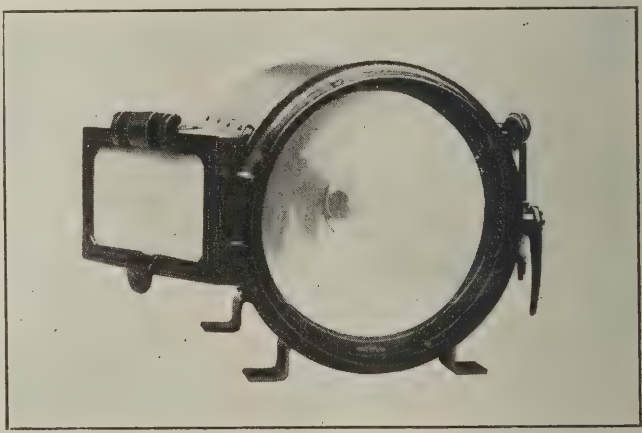
Provision is also made for using 300 and 500 watt lamps in this reflector when necessary.

Lead Coated Sheet Metal Headlight Case

A new type of headlight case known as type 20-F-270-BO, made by the Pyle-National Company, Chicago, Ill., includes a number of improvements and refinements of detail based on experience with the former standard design.

The headlight case retains the general appearance of the regular sheet metal cases. The body of the case is 16 gauge lead-coated copper bearing steel, and the goggle frame, number frames, and number light doors are of cast aluminum alloy. Joints between body and frame are packed with ⅛ in. lead packing and water-tight joints and non-corrosive materials are used throughout.

A retarding and locking spring of non-corrosive material is placed at the top of the number frame door, where it acts on the hinge lugs of the door, making the action of this door positive either opening or closing, and adding convenience to its operation. A latch spring, also of non-corrosive material, acts as a door lock on the lug cast into the bottom of the number frame door. A door handle is cast into the door as shown in the illustration. Placing the latch and spring inside the case protects both these elements of the mechanism and makes a simple and effective lock. The workman's hands are protected against accidental injury by the feature of placing the spring and latch inside the case.



Pyle National No. 20-F-270-BO Sheet Metal Headlight Case with Angle Side Number Frames

The number glasses are held in place by a new retaining spring device which holds the glass securely, even if the glass should be cracked in several pieces. There are eight contacts of the retaining spring around the edges of the glass and the spring can be readily re-

moved for replacement of the glass when necessary.

A standard tapped conduit flange is cast into the rear of the case, making extra fittings unnecessary. A straight run of conduit can be connected directly to the case through this flange, and the wiring brought to the connection block inside the case.

In addition to the lead-coated copper bearing steel case body, all hinge pins, bolts, and small parts are of non-corrosive materials.

The headlight case is regularly equipped with the Pyle-National 14 in. Nonglare glass reflector, and with the No. 550A focusing device which gives a simple and convenient means of making accurate adjustments of the focus of the lamp used. The focusing device is reached through one of the number frame doors, conveniently located when adjustment is required, and enclosed and protected during normal operation.

Across-The-Line Starters

Two new types of across-the-line starters, reversing and the non-reversing types, are now being manufactured by the Westinghouse Electric & Manufacturing Company. They are compact in design, and are easily accessible for installing and wiring. Two slotted hexagonal screws firmly hold the starter unit in place in a sheet steel cabinet. Thus the starter may be taken out as a unit, by merely removing these two screws with an ordinary screw driver, leaving all the room inside the cabinet for attaching conduit bushings and drawing in the leads.

The starter, consisting of a 3-pole contactor with electrical interlock, is completely enclosed and is operated entirely from a push button station located conveniently. In this way it provides safe control and eliminates damage which may be caused by tampering, or by unskilled handling. In addition to this safety feature, a boating armature type, three-pole contactor is used that provides smooth and positive contact. It is quiet in operation and the contactor's tips are kept clean by the rolling and wiping action in closing, thus preventing the tendency to heat or weld under load.

The Class 11-160 Non-Reversing Type Starter

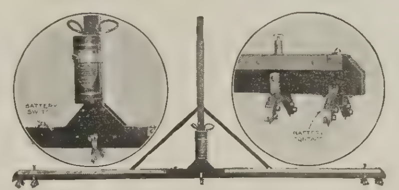
Where the operating conditions necessitate the protection of the starter against an accumulation of chips or other foreign matter, a door interlock may be had that makes it impossible to start the motor unless the cabinet door is fully closed.

The non-reversing starters, class 11-160, are applicable for use on machine tools such as lathes, boring mills, grinders and cutters; also for wood-working machinery, conveyors, blowers, and pumps.

The reversing type, class 11-165, is of the same sturdy and safe construction and has the same essential operating characteristics as the non-reversing type, in addition to a mechanical interlock which makes it impossible for both contactors to close at the same time. This type is used advantageously on turret lathes, machine tools, etc.

Bond Tester

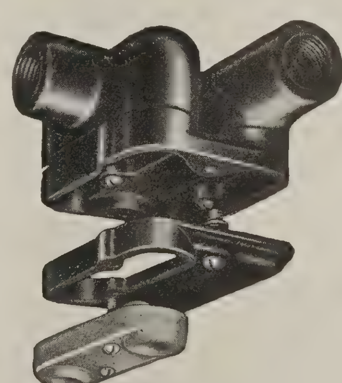
A bond tester equipped with a contact bar for use in testing rail bonds where the current is very feeble, has been developed by the Roller-Smith Company, New York, N. Y. With the aid of a dry cell, the tester can also be used when there is no current in the rail. Connections run from this dry cell to the spring contacts at the ends of the bar. In this circuit is a small foot-operated push switch mounted on the horizontal part of the bar adjacent to the upright member, which is depressed when there is no current in the rail and the battery must be used. The contact bar shown in the illustration is used in conjunction with a special type of portable galvanometer known as the type BBT bond tester.



Contact Bar of Bond Tester Showing Battery, Foot Switch and Rail Contacts

Condulet Branch Extensions

A condulet for branch extensions is now being offered by Crouse-Hinds Company, Syracuse, N. Y. The condulets provide a means of making extensions to existing conduit installations by bridging from one condulet to another through the cover opening; thereby making it unnecessary to alter or cut into the existing conduit line. Covers for the condulets are made both blank and with openings to take porcelain covers or wiring devices. The condulets are made for conduit sizes as follows: ½-½; ¾-½; ¾-¾; 1-½; 1-¾; 1-1; 1¼-1¼. Gaskets are provided for the covers.



Type O C B Branch Extension with Cover and 2-Wire Porcelain Cover Bridging from Type C to Type B Condulets

GENERAL NEWS

A train was buried in a landslide near Sarajevo, Bosnia, on July 17, according to reports from Vienna. Casualties reported were 117 persons killed.

For the electrification of the Cape Town suburban railways, the total estimated cost of which is £428,062, the sum of £100,000 has been set aside for the current financial year.

The Interstate Commerce Commission has postponed until January 1, 1927, the effective date of its first and second automatic train control orders as to the Pennsylvania, on petition of the company, dated July 21.

The Interstate Commerce Commission has postponed the effective date of its second automatic train control order in the case of the Louisville & Nashville and the Richmond, Fredericksburg & Potomac to January 1, 1927.

The Kuhlman Electric Company, Bay City, Mich., manufacturers of power, distribution and street lighting transformers, has established a factory office at 3-260 General Motors Building, Detroit, Mich. Richard P. Johnson is in charge of this office.

The Triumph Electric Corporation, Cincinnati, Ohio, has announced that it has acquired the good will, records, designs, patterns and patents of the Triumph Electric Company. It is the intention of the Triumph Electric Corporation to retain the old personnel so far as practicable in order that Triumph customers may suffer no interruption of service.

The Interstate Commerce Commission has postponed the effective date of both its first and second automatic train control orders in the case of the Long Island to January 1, 1927. In the case of the Delaware & Hudson the commission has postponed the effective date of the second order to January 1 and in the case of the Reading the date has been postponed to December 31. The commission also modified its order as to the Reading to permit the installation to be made between Bethlehem and Jenkintown, Pa.

The Chicago & Eastern Illinois has been granted an additional extension of time, to October 18, by the Interstate Commerce Commission, in which to complete the automatic train-control installation required by the commission's second order (January 14, 1924). The commission has also modified its first order (June 13, 1922) to authorize the Boston & Maine to make its installation between the East Deerfield, Mass., and West Cambridge, Mass., in lieu of the installation required between Boston and Greenfield, Mass.

Orders received by the General Electric Company for the first six months of 1926 totaled $165,405,720, representing an increase of 10 per cent over the $150,315,228 booked in the corresponding six months of 1925, President Gerard Swope has announced. For the three months ending June 30 this year, orders totaled $78,972,062, compared with $66,468,992 for the second quarter of 1925, an increase of 19 per cent. In the first six months of this year there were 152 working days, including Saturdays, showing General Electric orders received thus far this year have been at a rate of better than $1,000,000 per day.

Fall Meeting of the American Welding Society

The fall meeting of the American Welding Society will be held in Buffalo, November 17, 18, and 19. An international welding and cutting exposition which will be held in connection with the meeting which will open Tuesday afternoon, November 16. The technical sessions include railroad, welding apparatus, welding science in the engineering curriculum of universities, and welding in a gaseous atmosphere. The entertainment includes a trip to Niagara Falls, a view of the Falls from the American side, with an inspection trip through the Niagara Falls power house, a buffet supper on the Canadian side and a special illumination of the Falls. There will be the usual annual fall banquet and a meeting of the American Bureau of Welding, the Board of Directors and the Welding Wire Specifications Committee.

Westinghouse Contracts for Arc Welded Steel Structural Buildings

The letting of contracts for the erection of two arc welded steel structural buildings for the Westinghouse Electric & Manufacturing Company, was announced on July 28, by W. S. Rugg, vice president of the company-

pany. The two proposed structures include a one story building to be used as an engineering laboratory in the East Pittsburgh works, and a five story mill type building to be used in the manufacture of transformers in the Sharon works of the company. The five story building at Sharon, when completed, will be the largest arc welded or rivetless building in the world. It will be the first building in which all of the joints and members will be designed for arc welding.

Erie Requests Extension in Train Control Time Limit

The Erie, in a petition presented to the Interstate Commerce Commission on June 22, requests extension of time to the end of this year for the completion of the installation of automatic train control on its Delaware division, and the indefinite suspension of the commission's second order which calls for the installation of automatic stops on a second division of the road. The petition is supported by a statement to the effect that notwithstanding diligent prosecution of the work by the railroad company, and urgent requests to the manufacturer, the General Railway Signal Company, material has not been delivered with necessary promptness; and material needed from other manufacturers has been subject to delay because the road, seeing the comments of the commission on the tests of similar devices on other roads, concluded that some parts of the material ought to be made of more substantial type; and changes in the specifications were actually made on March 16, 1926. Further, with the best efforts of the road, it will be impossible to complete the Delaware division before December 31, next. The installing of apparatus on the locomotives has been divided between three shops, in order to hasten the work.

Uniformity with automatic train control apparatus on other roads is deemed by the Erie particularly important, as the locomotives of four or five other roads use parts of the Erie tracks. Again, the Erie has the heaviest train loading of any railroad in the country having equivalent car loading, and therefore is particularly interested in a satisfactory split-reduction application of the air brakes on long freight trains; and its experiments have been expressly directed to this end, but have not yet disclosed an entirely satisfactory device.

Considerable and important structural changes are now taking place in devices of the design selected by Erie. These changes are such as the elimination of ballast lamps, the reduction in the number of relays on locomotives from three to one, the modification of the design in the headlight generator to eliminate possibility of grounds which might result in false clear indication because of these grounds, the modification of the receiver so as to increase the air gap without interfering with operating efficiency, and the modification of the standard wiring on locomotives so as to eliminate possibility of grounds both in the train control circuit and in the lighting circuit. Therefore, it is submitted that the Delaware division should be finished before beginning on a second division.

The company needs to install automatic block signals between Cuba Junction and Meadville, Pa., 133 miles, in order to complete the automatic system between New York and Chicago; and if relieved from the additional burden of installing automatic train control on a second division, it is prepared to proceed promptly and diligently with the installation of these automatic block signals.

The commission has announced an extension of time under its second order for the St. Louis-San Francisco to December 31 and for the Chicago, Indianapolis & Louisville to January 1.

Extensions of Time for New York Electrification

The Public Service Commission of New York, acting under authority of a law passed by the Legislature last winter authorizing it to grant an extension of time not exceeding five years for steam railroads operating within New York City to complete electrification of their lines in compliance with section 53-a of the Public Service Commission law, has announced its decision upon the applications of five railroads for such extension.

The New York, New Haven & Hartford was given an extension until July 1, 1928, to comply with the law. Much of the work required had been done prior to the amendment passed by the legislature last winter. Remaining work to insure compliance is equipping for electrical operation that part of the Long Island Railroad which the New Haven operates under trackage agreements between Fresh Pond Junction and Bay Ridge and equipping the freight tracks of the New York connecting line from Port Morris across Hellgate bridge to Fresh Pond Junction.

Petition by the Staten Island Rapid Transit for a five years' extension was denied. The company's passenger facilities have been electrified. The freight service has not as yet been electrified. The larger percentage of the freight service is interstate traffic, coming from western points by way of New Jersey. Chairman Prendergast in a memorandum says electrification of such through freight service would require rebuilding of the Arthur Kill bridge at a cost said to approximate $6,000,000, and electrification of terminals and other facilities, approximately $4,000,000. Petition by the Degnon Terminal Railroad, operating a terminal line in the Borough of Queens from west of Pearson street connecting there with the Long Island, running west to near School street, a distance of about half a mile, for an extension of five years from January 1, 1926, in which to comply with the law, was denied. Petition by the Brooklyn Eastern District Terminal for a five years' extension was also denied.

The Pennsylvania, covering operation in its Sunnyside Yard in Queens and 37th street and North Fourth street yards in Manhattan, was given an extension until January 1, 1927.

Personals

B. M. Horter, formerly of the Philadelphia office of The Cutler-Hammer Manufacturing Company, has been appointed manager of the company's Boston office. He succeeds J. M. Fernald, who has resigned to enter a different field of business.

P. W. Miller is now associated with the sales organization of the Hazard Manufacturing Company, Wilkes-Barre, Pa., and will make his headquarters at the New York office, 533 Canal street, New York, N. Y.

Mr. Miller was formerly associated for a number of years with the Kerite Company.

J. N. Mahoney has been appointed manager of engineering, American Brown Boveri Electric Corporation, 165 Broadway, New York, N. Y. In this capacity the organization and details of operation of the entire engineering staff come under his jurisdiction. His capacity is executive while that of the chief engineer is consulting.

Obituary

Franklin S. Terry of Cleveland, Ohio, vice-president of the General Electric Company and for years a leader in the incandescent lamp business, died suddenly of heart failure at his summer home at Black Mountain, near Asheville, North Carolina, on July 23. He had been in good health and the week previous to his death attended Camp General, a gathering of General Electric officials, at Association Island, near Henderson Harbor, N. Y.

Mr. Terry was born in Ansonia, Conn., in 1862 and held his first position with the Electrical Supply Company of Ansonia. In 1889 he organized the Incandescent Lamp Company of Chicago and four years later took personal charge of the Company. In 1901 the National Lamp Company, of which he was a founder, purchased the Sunbeam Company. A few years later the National Lamp Company merged with General Electric, Mr. Terry remaining with the National Lamp Works, Nela Park, Cleveland, Ohio. He was one of the organizers of the National Electric Light Association.

He devoted his genius as an organizer to the betterment of the manufacture and quality of incandescent lamps. Mr. Terry possessed an extraordinary ability for training and developing young men and his qualities as a leader were indicated by the splendid spirit which prevailed throughout his lamp organization.

Charles A. Coffin, founder and for 30 years head of the General Electric Company, Schenectady, N. Y., as president and chairman of the board of directors, died on July 14 at his home in Locust Valley, Long Island, N. Y. Up to within two weeks of his death Mr. Coffin had been regularly to his office in New York and continued his active interest in the progress of the electrical industry and more particularly the General Electric Company, of which he was a director.

Charles Albert Coffin was for 30 years the financial and commercial genius of the General Electric Company. Prior to the formation of that company, in 1892, he was with the Thomson-Houston Electric Company, one of the predecessors of General Electric. Mr. Coffin was born in December, 1844, in Somerset county, Maine, and graduated from Bloomfield (Me.) Academy. He went to Boston as a young man and became interested in the shoe and leather industry. Mr. Coffin, with Micajah P. Clough, formed the firm of Coffin & Clough, and established a factory at Lynn, Mass., one of the largest shoe manufacturing centers.

In 1883 Mr. Coffin became interested in the purchase of the American Electric Company of New Britain, Conn., a small concern, the head of which was Professor Elihu Thomson. The business was moved to Lynn and the name changed to the Thomson-Houston Electric Company in honor of Professor Thomson and his early associate, Professor Edwin J. Houston. Mr. Coffin became its vice-president and treasurer, and through his leadership the company developed the central station idea as applied to arc lighting. In 1888, he induced the company to enter the electric railway field, manufacturing equipment for electric street car lines in many parts of the country. A number of other electrical concerns were absorbed, and in 1892 the Thomson-Houston Company was consolidated with the Edison General Electric Company of New York under the name of General Electric Company. Mr. Coffin was immediately elected president, and directed its affairs for the succeeding 21 years.

During the electrical development of the late nineties and early years of the new century, he continued to exercise strong and inspiring leadership. He supported the work of his company's engineers in developing the Curtis steam turbine, which revolutionized the primary power sources in electric light and power stations, and he endorsed the movement to establish, in 1901, a laboratory for electrochemical research which grew to be the research laboratory of today.

Mr. Coffin retired from the presidency of the company in 1913, but became chairman of the board of directors, remaining in active participation in the company's affairs until 1922. In 1915 he was engaged in organizing the War Relief Clearing House for France and her allies. This was later consolidated with the American Red Cross in which Mr. Coffin was active throughout the World War.

Trade Publications

Willard Storage Batteries for Railroad Service is the title of a 16-page illustrated bulletin recently issued by the Willard Storage Battery Company at Cleveland. The booklet is known as bulletin No. 181 and includes descriptions of batteries such as are used in train lighting, signaling, train control, telegraph, telephone, radio, time recording devices, gasoline rail cars and motor buses.

Westinghouse Electric & Manufacturing Company have released six additional sheets of electric locomotive data, leaflet 20190, sheets 21 to 26, inclusive, covering Virginian, Detroit, Toledo & Ironton; Buenos Aires and Western; Imperial Government Railways of Japan; Norte Railways of Spain, and Dutch East Indies State Railway. East sheet covers a certain type of locomotive giving the salient mechanical and electrical data of that particular type.

General Electric Catalogue 6001*B*, superseding all previous catalogues issued by the company, with the exception of those dealing with railway, mine and industrial supplies and merchandise products, is being distributed. The complete catalogue is issued every two years. The book is two inches thick, and contains more than 1100 8 x 10½-in. pages. The illustrations total more than 3200. The catalogue is thumb-indexed into 16 sections as follows: Generation, wire and cable, distribution transformers, arresters, voltage regulators, switchboards and accessories, meters and instruments, motors, motor applications, industrial control, railway, lighting, industrial heating, miscellaneous, and indexes. In the indexes, products are classified both by subjects and by catalogue numbers.

Railway Electrical Engineer

Volume 17 SEPTEMBER, 1926 No. 9

Electrical Kink Competition

Cash in on your experience by entering this competition. Its object is to obtain the practical ideas of railway electrical men to be published in the *Railway Electrical Engineer* so that all may profit by an interchange of ideas. Three cash prizes are offered for the best practical electrical kinks, methods or devices which are time, trouble or labor savers. The prizes will be awarded as follows: For the best two practical kinks, methods or devices, \$50; for the second best set of two, \$35; for the third best set of two, \$20.

All contributions submitted which are suitable for publication but which do not win prizes, will be paid for at regular space rates. If more than two kink descriptions are included in a prize winning contribution, space rates will be paid for those descriptions which may be published and on which the prize award was not based. All suitable material will, therefore, win remuneration.

The length of contributions will not be the determining factor in selecting the prize winner. Descriptions of 500 words or less for each kink are the most desirable. Photographs, drawings or sketches are desirable and should accompany descriptions whenever possible. The sketches need not be made on a drawing board because we can straighten out the lines.

Do not feel that you are not able to write well enough to enter such a competition. The thing that will count will be the extent to which the method or device submitted is valuable in saving labor or time. The *idea* is the thing, not the manner in which it is presented. A simple method for writing such articles is outlined in the first article of the Interchange Section in this issue. You are not restricted to two kinks, methods or devices but may send as many as you like. The award being on the basis of what the judges believe to be the best two in the collection.

Articles will be received by the editor of the *Railway Electrical Engineer*, 30 Church Street, New York, N. Y., up to but not later than November 20, 1926, and the announcement of prize winners will be made as soon thereafter as possible. Manuscripts will be returned if you so request. We want to use your name, if possible, but it can be withheld if you so desire. Here is an opportunity to make your experience and effort pay you real returns. Start now, before it is too late.

Train Control Situation

At the time the first order of the Interstate Commerce Commission was issued requiring the installation of automatic train control systems within a prescribed time, these systems had few, if any, friends among railroad officers. The aspect has changed considerably; orders have been modified, times of installation have been lengthened, and the spirit of leniency has taken the place of the stern attitude of the first edict.

Withal, the installation work has been progressing in a generally satisfactory manner as may be seen from a summary of the territory covered. Installations required under the first order included about 3,760 locomotives and 7,860 miles of track. Of this total, 83 per cent of the locomotives and 77 per cent of the track are operated under automatic train stop system which does not incorporate the speed control feature in an occupied or caution block, while 17 per cent of the locomotives and 23 per cent of the track are equipped for train control, including speed control. Further, of these installations, 62.7 per cent of the locomotives and 57.2 per cent of the track are equipped with intermittent devices, while 37.3 per cent of the locomotives and 42.8 per cent of the track are equipped with continuous control. These percentages give a more accurate index of the type of apparatus involved than is shown by the number of roads using each type.

It is interesting to note that all types of train control are being used on both single and double track and on lines with both comparatively light and heavy traffic.

There is a great demand for specific information concerning the methods of train control maintenance and inspection, but as the subject is so new, relatively few of the roads have succeeded in building up anything like established practices in this respect. Descriptions of the apparatus and operation of the different train control systems are readily obtained from the designers of the various types of apparatus, but the maintenance kinks,

practices and methods will have to be worked out by the roads themselves.

Oil for Headlight Bearings

Years ago automobile operators came to the conclusion that it was desirable to change the oil in the crank case of the engine every thousand miles. Later, the majority decided that if the oil was changed every 500 miles, the added insurance of long wear was worth more than the additional cost of the oil. A few even change oil every 300 miles and designers of cars are now developing devices for filtering the oil and intake air and for removing gasoline from the oil while the engine is in operation.

Conditions which govern the condition of the oil in a headlight bearing and in an automobile engine are somewhat different, but they are also similar in several respects. Oil in a gas engine acquires carbon, gasoline, dirt and moisture. The headlight bearing is not subject to the first two, but dirt does get in and it is extremely difficult to keep moisture out.

The experience of one eastern road indicates that headlight maintainers can profitably take a tip from the automobile industry and, though it may seem wasteful, change the oil in headlight set bearings more often. A few years ago, on the particular road mentioned, records showed the life of a headlight set bearing to be about 15 months. A decision was then made to change the oil in all bearings once a month. The result was that bearing life was increased to two years on the same headlight sets. Some of the new bearing housings are better than the old ones and it remains to be decided just how often oil should be changed in different sets in order to balance the cost of oil against the cost of a new bearing. It is hoped that before long the railroad headlight maintainers will develop a uniform method of keeping headlight cost records. When this is done many such points can be intelligently decided. The result will be large savings to the railroads and improved dependability of headlight equipment.

The Virginian Power Plant

The casual observer, on seeing the plant which supplies power for the Virginian electrification, cannot help but be impressed by the size and height of the two stacks which furnish draft for the fires. If the same observer were to look over the plant he would probably conclude it was a fine large plant and let it go at that.

A student of electrical developments, however, will find much to interest him. First he will see that the plant is equipped to burn a very low grade of coal in pulverized form. This means that the cost of fuel will be low and that the rate of burning can be varied readily to comply with large power loads which vary over wide ranges, as the 6,000-ton trains are brought up the 2 per cent grade from Mullens to Clarkes Gap. Special devices are used to control the rate at which coal is fed into the furnaces, to control the drafts and the feed water supply so that they will conform with load demands.

The plant is unusual in that it generates three-phase power to supply a single-phase 25-cycle load; in case the locomotives at times regenerate more power than they use, the plant is equipped with apparatus to absorb this excess of power.

Elsewhere in this issue is an illustrated article describing the installation, in which particular attention is given to the electrical apparatus. It will be noted that the control is particularly flexible and that the switching arrangements are such that any piece of equipment may be removed for repair or inspection without disturbing the operation of the plant.

The plant is designed to supply a special need for power and it is not likely that many more like it will be built by railroads since there is an increasing tendency to purchase rather than generate power. The plant is, however, distinctly modern in every respect and contains many features or developments which can be used to advantage other electrical work installed under different circumstances.

Diesel Locomotive Drives

Different forms of drives which have been built for the purpose of connecting internal combustion engines to the wheels of a car or locomotive are many and various. The Diesel engine has been a practicable prime mover for nearly 30 years, but as it is essentially a constant torque machine some form of flexible drive is necessary between the engine and the driving wheels. The slow development of these forms of drives has been the principal reason for the comparatively limited use of the Diesel-locomotive.

The types of drives which have been tried consist of a selective gear drive, or a generator, pump or compressor, driven by the engine, which in turn drive an electric, hydraulic or pneumatic motor connected to the driving wheels. Most of the early development work was done in Europe and it is only recently that American engineers have given the problem much attention. The greater part of the American development has been with the electric drive. Real progress has been made and this fact seems significant. It is true that the companies which are responsible for the greater part of the development work had most of the necessary parts of the drive already developed and that of late there has been an increasing demand for rail motor cars and internal combustion locomotives.

On the other hand, it is a fact that development of the electric drive and the rapid increase in the use of these types of motive power have been coincidental. The electric drive has practically ideal operating characteristics and its development has undoubtedly had much to do with the increased use of cars and locomotives driven by internal combustion engines. Its objections are first cost and weight, but these factors are subject to modification and the electric drive is already meeting with success for relatively light highway buses as well as for locomotives. Other forms of drive may be developed which are better than electric for certain classes of service, but there is every indication that the electric drive will have a wide application and that it is here to stay.

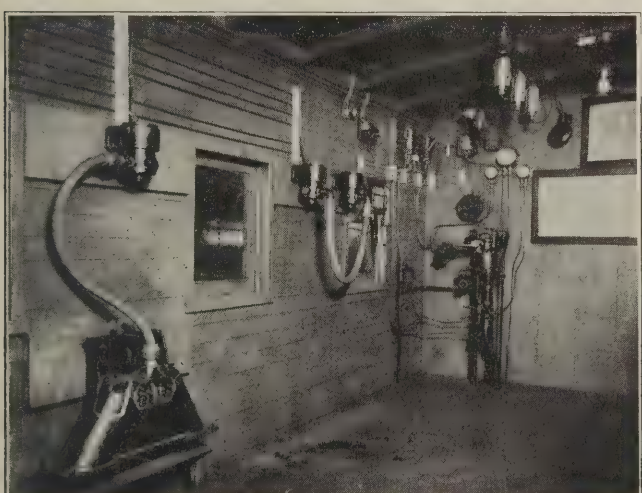
Train Control Shop Showing Remodeled Construction Car in Background

B. & O. Installs G.R.S. Auto-Manual Train Stop

Average Time for Equipping an Engine About 60 Man-Hours, Special Devices Used for Bending Conduit and Threading Pipe

By F. P. Patenall
Signal Engineer, Baltimore & Ohio, Baltimore, Md.

WHEN the Interstate Commerce Commission issued order No. 13413 of June 13, 1922, requiring the Baltimore and Ohio to install automatic train control on a locomotive division of its system, it became necessary to investigate the various systems and select one which was best adapted to meet its requirements.



Instruction Room Showing Train Control Equipment

The territory first selected by the railroad and approved by the commission was that part of the line between Baltimore and Washington. Although the distance between these two cities is only 36.3 miles, yet due to the very heavy passenger traffic, it was apparent that a system should be chosen which would meet the commission's requirements but not reduce the capacity of the line in the least.

After a detail study by the signal department it was recommended that a preliminary installation be made on a short section of this line just outside of Baltimore and that the General Railway Signal Company's Intermittent Inductive Tapered Speed Control System should be used. After tests were made in this equipped section it was thought that the system omitting the tapered speed control feature would satisfactorily fulfill the commission's requirements. The G-R-S Continuous Inductive Speed Control System was then tried. At a later date, however, the commission handed down a ruling which permitted the application of a forestalling feature in train stop operation. This ruling not only applied to their first order, but also to the second one which required the installation of train control between Baltimore and Philadelphia. Owing to this and to the fact that a system embodying the forestalling feature was better suited to the conditions, the General Railway Signal Company's Intermittent Inductive Auto-Manual Train Stop System was selected.

Organization Unique for Installing Engine Equipment

On February 8, 1926, the work of installing engine equipment was started. Five adjoining pits in Riverside Roundhouse, Baltimore, were assigned for this work. The two pits on each side of the center one are used for the installation work on locomotives and the center pit with its track provides space for a work car which has been fitted up as headquarters. Partitions were built in this car so as to form three connecting rooms. The rear

room is used as a store-house and is sufficiently large to hold 30 engine equipments in a well arranged and orderly manner, with the exception of the mechanism cases, receivers and receiver-mountings which, owing to their size, are kept outside of, but adjoining the car.

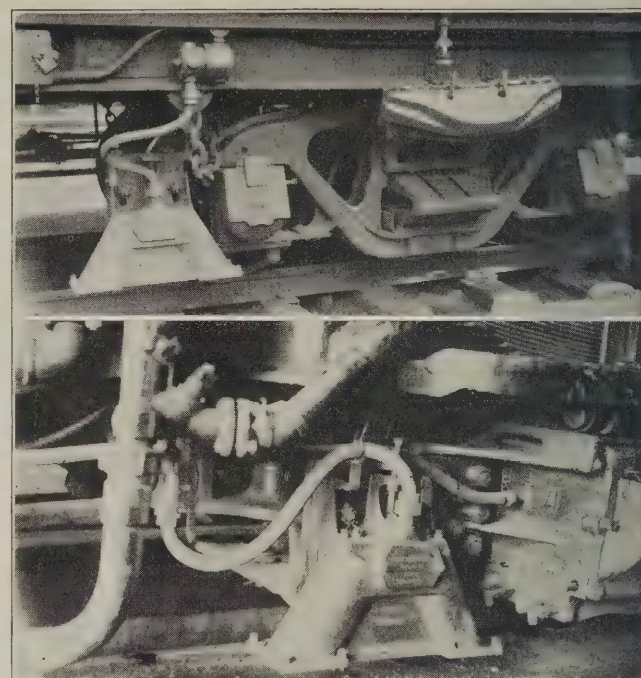
The middle room is used for demonstration and instruction on train control, a full engine equipment being in operation. Charts and diagrams also aid in explaining the location of the apparatus. All locomotive train-control construction crews, personnel of the shops at Philadelphia, Wilsmere, Baltimore, Washington, Brunswick and Cumberland and all those who have any contact with train control have been called at various times to the Riverside shops and there instructed in the operation of the system.

The front room of this car is arranged as an office for the supervision of engine installation work. The crew, working one shift of eight hours, consists of 12 electricians, 5 machinists, 3 pipe-fitters, 3 pipe-fitter helpers and 2 boiler makers.

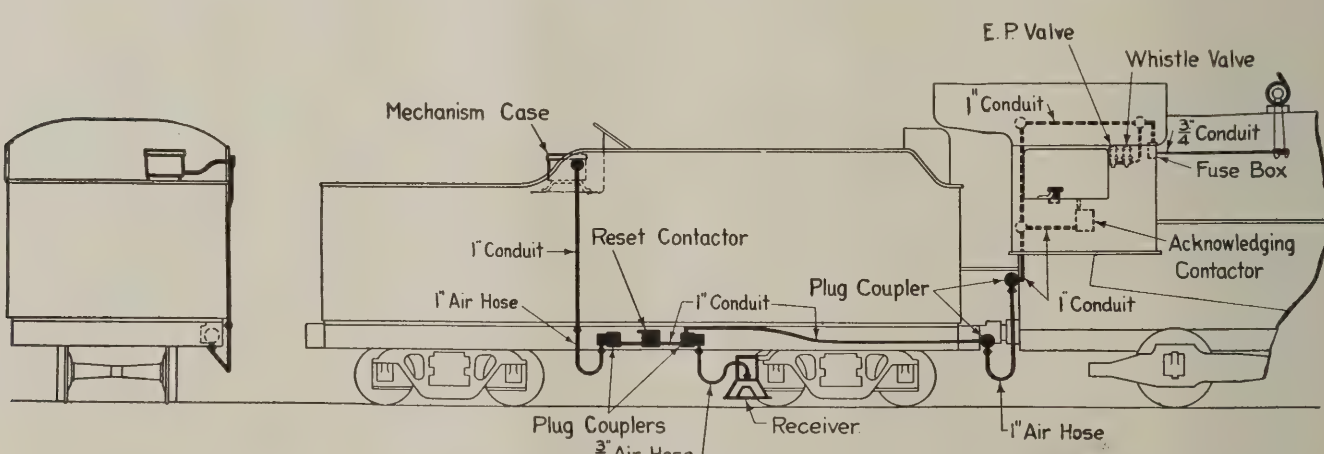
59-5/6 Man-Hours, Average Time per Locomotive

Work on the first locomotive was started February 20, and finished February 26, in 109¾ man-hours. The maximum time required was 150 man-hours to equip a Mikado locomotive which had a Vanderbilt tank. As the work progressed the time per locomotive was greatly reduced, as the average time required to install equipment on 117 engines was 59-5/6 man-hours. The minimum time for a locomotive was 48 man-hours. Locomotives were released in approximately six hours after entering the roundhouse for train control equipment.

This good record was primarily due to the personnel and the well planned layout, but several aids were devised which have facilitated the work to a considerable extent. The first aid consisted in establishing a typical or standard installation which permitted cutting and bending conduits in quantities. This was supplemented by several devices especially designed for the work in hand, among which were: a conduit bending machine, a pipe threading machine for conduit, a furnace used for bending all braces and brazing on train control work and a drilling machine for drilling the tender frames. Speed was accomplished in assembling the conduit runs on the bench with contactors, couplings or other fittings attached and all wiring in place. The third aid resulted from locating the electrical couplers between the engine and tender slightly above the level of the draft gear and locating a vertical riser about midway on the side of the tender. The location of the apparatus and the electrical connections are shown in two diagrams. This arrangement very materially reduced the amount of conduit, wiring and labor required. It also offered further advantages in that the couplers were more easily inspected, readily accessible, and were not likely to be overlooked when uncoupling tender from engine.



Above: Receiver Mounting—Andrews Truck. Below: Receiver Mounting—Commonwealth Trailer



Location Plan of Train Control Apparatus

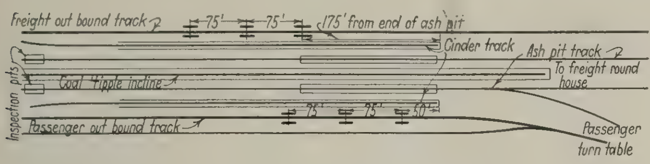
Territory Between Baltimore and Washington Now in Service

At 12:01 a. m. June 1, 1926, the territory between Baltimore and Washington was tentatively placed in service for test and observation. Ninety-eight equipped locomotives and all of the track equipment were put in operation, and have been continued since that time, when on July 1, 1926, the full complement of locomotives re-

quired under the order (130) had been equipped, finished and placed in operation, since which time successful performances have been recorded.

The Outbound Test

After each locomotive is made ready for the road and has had its train control equipment inspected and sealed



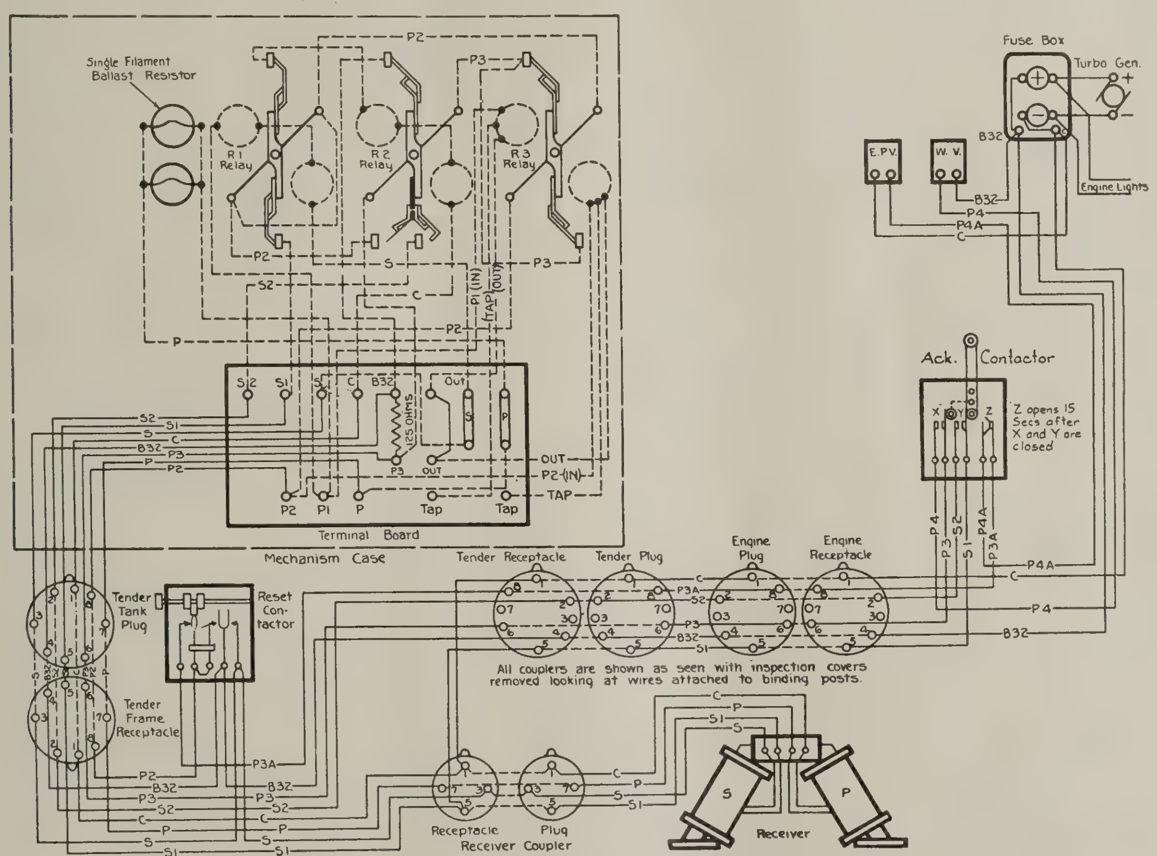
Outbound Test Track Showing Test Inductor Locations on Freight and Passenger Tracks

it is placed on one of the two outbound test tracks, depending on whether it is for freight or passenger service. It is then turned over to the road engine crew whose engineman proceeds to test out the train control equipment to satisfy himself that it is in operating condition before he leaves the yard. Each outbound track has two inductors at each location for use in either forward or backward movement. As shown on the track plan, there are three inductor locations on each track, spaced 75 ft. apart.

The first inductor to be passed over is wound and on closed circuit which produces a similar condition to that encountered when passing a clear signal. The second inductor passed is unwound which produces a similar condition to that encountered when passing a caution or stop signal. Here the engine man operates his forestalling switch which tests his whistle valve and prevents a brake application. The third inductor passed is also unwound and produces a similar condition to that encountered when passing a wayside signal at stop or caution. Instead of using the forestalling switch to prevent a brake application he avoids its use and allows his brakes to be set automatically. He has thereby encountered on this test track those conditions which he will find on the road, and, having found the system to operate satisfactorily, he resets the system by means of the reset contactor on the side of the tender and proceeds out of the yard.

Inbound Inspection

Each locomotive which is equipped with train control is thoroughly inspected on entering the yard and a report is made out to show the condition of the train control equipment, its circuits and what repairs or adjustments are required. A copy of the report form used is shown. In addition to the inspection required to fill in the report form, the inspector checks the voltage of the turbo-generator, tests for any grounds in the circuits, examines the turbo-generator and its lubrication supply. He also examines the headlight, cab and classification lights, all conduit and the mechanism case.



Wiring Diagram of Train Control Apparatus

Maintenance of Equipment

The maintenance of engine equipment will come under the supervision of the master mechanic and requires the following force:

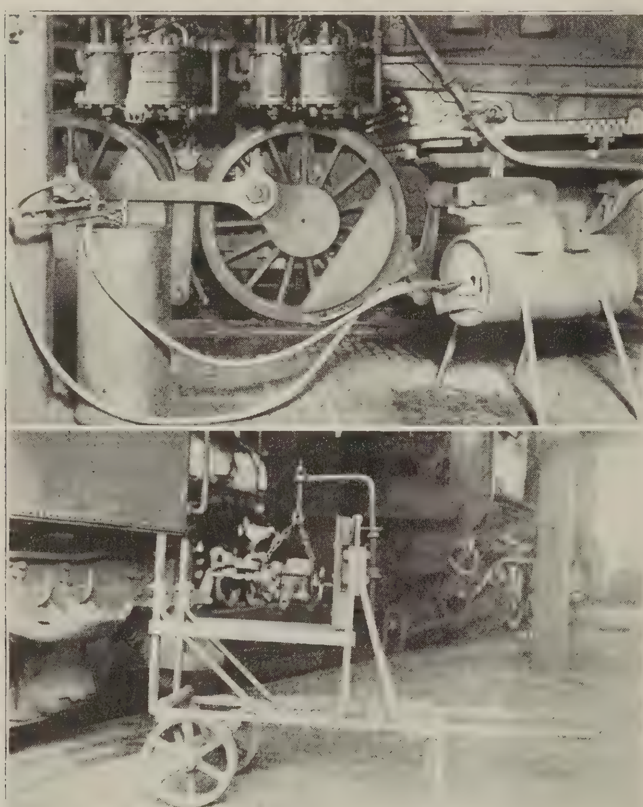
3 maintainers at Riverside Shops, Baltimore,
2 maintainers at East Side Shops, Philadelphia,
2 maintainers at Brunswick Shops located between Washington and Cumberland,
2 maintainers at Cumberland Shops, Cumberland.

Wayside Equipment Handled by Signal Forces

All wayside inductors, together with the circuit extensions and revisions of circuits, were installed by the signal floating construction force. There were 65 inductors installed, the average number of man-hours per inductor installation being 259. A close-up view of an inductor location shows the trunking connections to the inductor, the trunking lead from the signal to the inductor, and the method followed so as to keep each wire separate to itself. The inductors are located 70 ft. in advance of the signal in the direction from which it is approached.

Object and Operation of the System

The object of the Intermittent Inductive Auto-Manual Train Stop System is to enforce observance of the



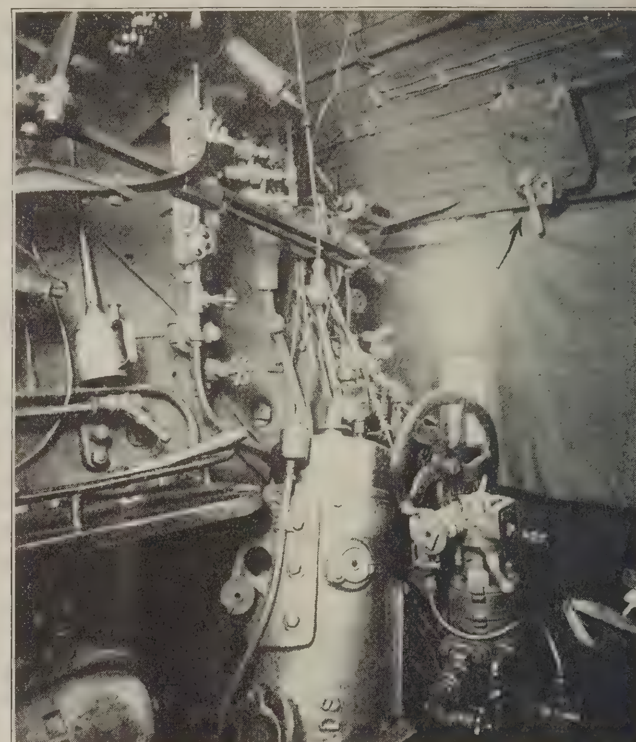
Above: Furnace for Use in Bending Braces and Brazing on Train Control Installation Work

Below: Specially Designed Drilling Machine for Drilling the Tender Frames

caution and stop indication of wayside signals. The system causes an automatic brake application until the train is stopped in case the engineman passes a caution or stop signal without performing a manual act called forestalling. The forestalling prevents the automatic application from taking effect as the signal is passed and proves that the engineman is alert and aware of restrictive conditions.

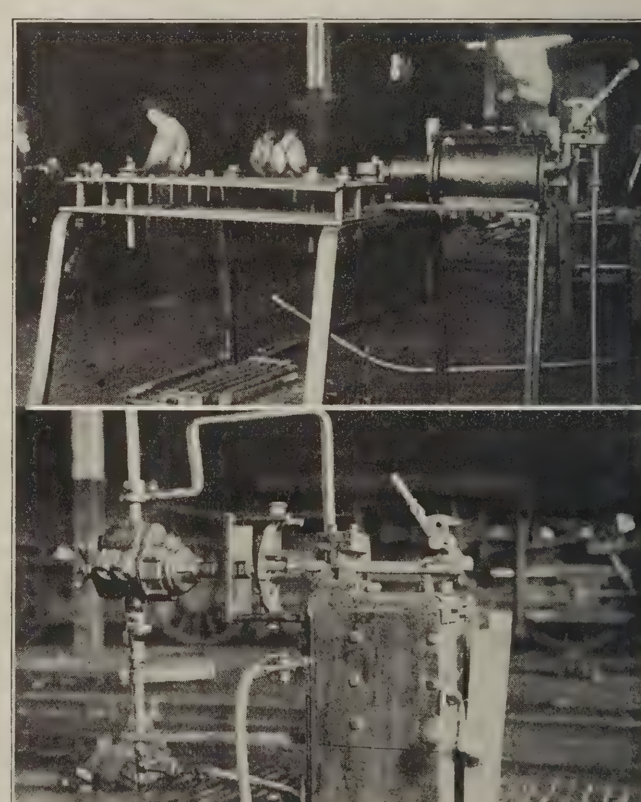
Instead of a long, detailed description of the operation of the circuits which has appeared in previous issues, the following is given as a brief non-technical description on the operation of the system:

An inductor is located approximately 70 ft. from each signal governing the entrance to a block in the direction from which the signal is approached and is placed just outside the right hand rail. Although this inductor is electrically connected to its signal, it carries no current. Its purpose is to react on the engine electrical apparatus by means of the receiver on the passing locomotive, the



Forestalling Switch Installed in Cab, Actuator on Engineman's Brake Valve

caution or stop indications displayed by fixed roadway signals. A receiver is mounted on the right side of the



Above: Conduit Bending Machine for Train Control Installation

Below: Pipe-Threading Machine for Threading Conduit Used on Train Control Installation

forward tender truck of the locomotive in such a location as to pass two inches above and directly over an inductor. Associated with this receiver is a relay group which is mounted in a case located on top of the tender tank as shown. Also associated with this receiver and the relays mentioned is an electrically operated air valve which is located in the locomotive cab and which controls the air supply for operating the brake valve actuator. The brake valve actuator is used for the purpose of moving the engineman's brake valve by pneumatic power to the service position.

AUTOMATIC TRAIN CONTROL

INTERMITTENT INDUCTIVE AUTO MANUAL TYPE

Daily Inspection Report

Date Place

Engine No.

Time Inspected

	REMARKS		
1 Height of Receiver above rail			
2 Are receiver mounting bolts up tight and nuts locked?			
3 Has receiver been struck by any roadway obstruction?			
4 Start generator and pump then reset system			
5 Does actuator latch up in service position?			
6 Does bar test apply brakes without acknowledging?			
7 Reset system and latch up actuator			
8 Reset again Do brakes apply?			
9 Does actuator latch up O.K. after releasing reset button?			
10 Does bar test apply brakes when acknowledging?			
11 Does audible whistle sound?			
12 Acknowledge until time element runs out, giving time in seconds			
13 Do brakes apply?			
14 Release Ack. lever. Does actuator latch up O.K. without resetting?			
15 Actuator and E.P. and A.W. valves. (Are there any air line leaks, etc.?)			
16 Control Cutout Cock (Position found			
(Position left			
17 Condition of Plug Couplers			
18 Condition of Plug Coupler Hose			

Electrician

Daily Inspection Report

As the locomotive passes a wayside signal which displays a caution or stop indication its receiver passes over an inductor which causes a magnetic surge in the receiver. This surge is utilized to open the contacts of the relay group which in turn disconnects energy from the electrically operated air valve. This exhausts air from one end of the actuator cylinder and causes the actuator to move the engineman's brake valve to the service position, thereby applying the brakes until the train is stopped. The engineman cannot release the brakes from this application until the train has come to a full stop, but he can operate his brake valve to the emergency position if he desires.

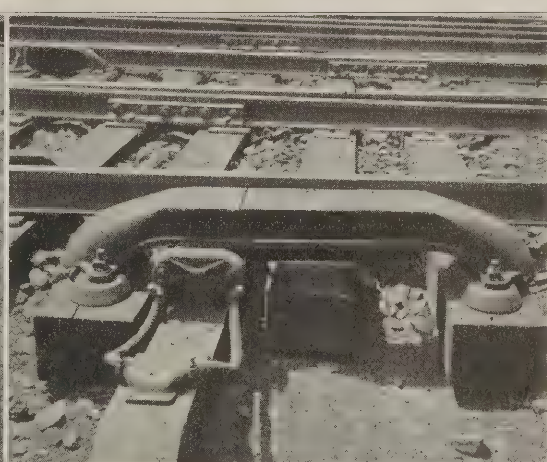
After receiving an automatic application of the brakes as described, the electrical apparatus on the locomotive is restored to normal condition by the operation of a reset contactor, which is located on the engineman's side of the tank about midway between the front and rear on the tank sill. The push button of this contactor is pressed inward for two seconds which restores all of the electrical equipment to normal and resets the actuator so that the engineman may, by the manipulation of his brake valve handle release the brakes and proceed.

If, when passing over the inductor at a caution or stop signal, the engineman operates his acknowledging contactor or forestalling switch it prevents the magnetic surge in the receiver from disconnecting energy from the electrically operated air valve. Two of the relays in the relay group open momentarily and sound a shrill whistle which informs the engineman that the acknowledgment is complete and the automatic brake application has been forestalled after which he releases the handle of the forestalling switch and the train proceeds without the automatic train control becoming effective. The acknowledging contactor or forestalling switch is so arranged that if the engineman holds the handle down for a longer period than 15 seconds the electrically operated air valve is deprived of current and causes the actuator to move the brake valve into the service position. The brakes may be released from this application, however, as soon as the acknowledger is released and does not require the operation of the reset contactor. The operation of the acknowledging contactor or forestalling switch not only proves that the engineman is aware of the signal indication but also proves that he is alert in that the operation must be completed within 15 seconds in passing the signal.

It should be said that the locomotive engineman has

Showing Location of Inductor to Running Rail

Trunking Lead from Signal to Inductor



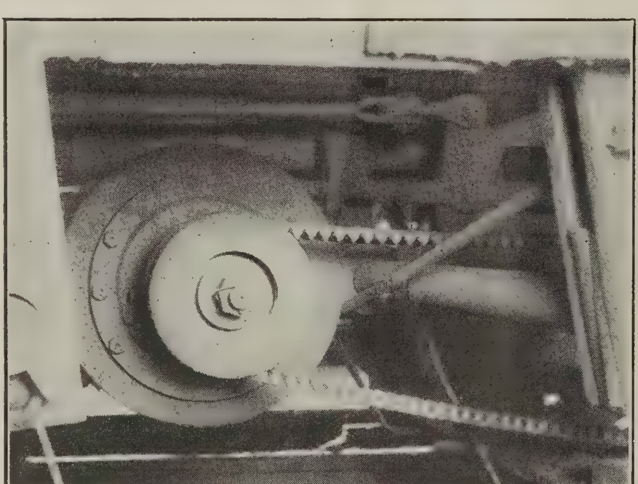
Close View of Inductor Location and Trunking Connections

always been regarded by the Baltimore and Ohio as a diligent, careful and faithful employee and that this system is, therefore, installed in such a manner as not to take away any of his duties, but as an aid and a protection to him and his train, should he for any reason fail to see a restrictive signal or suddenly become unable to perform his duties. All that the train control system requires of him is to prove that he is alert and aware of conditions by operating the forestalling switch at each and every caution or stop signal which he passes.

Chain Driven Axle Lighting Units

While the majority of car lighting generators installed individually on coaches, employ the belt drive both in truck and body hung suspensions, there is one road which began to use a chain transmission about 10 years ago and which is now operating all of its passenger equipment with this type of drive. Although this road, the Duluth Missabe & Northern, does not make any claim of heavy passenger business the reasons given for the elimination of belts and the installation of a more positive drive should be of interest to others.

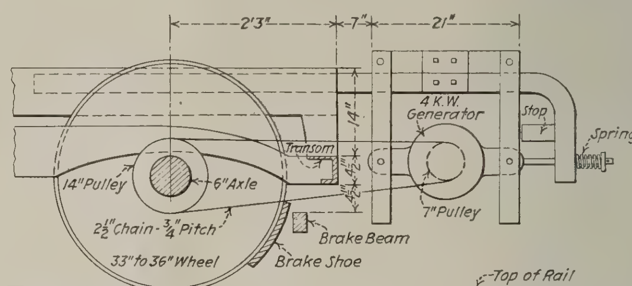
After attempting to use every type of belt on the market including leather, composition and rubber, experiments were initiated toward developing some satisfactory system to replace belts. This was prompted



Average Service Life of These Morse Rocker Chains Is Between 225,000 and 250,000 Miles

largely by the severe climatic conditions existing on this line, the temperature ranging between 40 deg. below to 100 deg. above zero, with heavy snow and ice experienced in the winter. Records of performance show that even rubber belts, which gave a little better service life than any of the others, had an average life of only two months.

The success which has been attained with the chain drive is attributed largely to the type of chain used, the tension between links being transmitted by a knife edge contact that reduces wear between links as compared with the usual type of chain. The generator, a 4 kw. 4-pole slow speed Safety machine, is suspended from the truck by the usual pivoted cradle constructed of bar steel and is properly tensioned with a spring attachment limited by an adjustable stop to prevent the chain being pulled too tight, which would cause excessive wear. A 14-in. diameter split driver sprocket with 4 in. face and 59 teeth is centrally mounted on the truck axle and a 7-in. diameter driven sprocket with 2 5/16 in. face and 29 teeth with ¾ in. flange is used on the generator. A 2¼ in. wide, Morse rocker-type chain of ¾ in. pitch is used with a sag on the top half of about 1 in. It is advisable with a chain drive not to exceed a peripheral speed of 2,000 ft. per min. This requires a slightly lower pulley ratio than with belts and a higher cut-in



Dimensional Sketch Showing Application of the Chain Drive

speed. Although this is an apparent limitation no trouble has been experienced in adjusting the regulators to permit a higher cut-in speed.

All chains are lubricated with a mixture of cylinder oil and graphite applied with a brush, the graphite acting as a shield to keep out the grit and sand. The average life of a chain on the Missabe is between 225,000 and 250,000 miles. To prevent breakages all chains are removed after this mileage has been reached. When installing a new chain experience has dictated that both gears be removed, otherwise the full life of the chain will not be realized.

In all, a total of 18 cars are equipped with chain drive axle units, according to A. M. Frazee, electrical engineer of the road.

Ewing Galloway

Preliminary Work on New Union Station, Cleveland, O.


Most of the Armature Rebuilding Is Done in This Corner of the Shop

St. Paul Handles Electrical Repairs Economically

Shop at West Milwaukee Enables Substantial Savings to Be Made on All Repair Jobs

THE electrical repair shop on a steam railroad is deserving of the best attention that can be given to it, both as to the equipment provided as well as the methods of handling the work according to the experience of the Chicago, Milwaukee & St. Paul, in its repair shop at West Milwaukee, Wis., where all kinds of motor and generator rebuilding is performed. Armatures for 250-kw. generators and 260-hp. motors have been rewound in this shop, but much of this work is for the smaller sizes as used in headlight generators. This shop receives damaged electrical equipment for repair from all points east of Mobridge, S. D.

For this work there are 15 men regularly employed in the shop and on trouble work in the terminal, and 8 road men who devote most of their time to traveling over the territory on construction, maintenance or special repair work that can be carried on efficiently on the ground or where conditions prohibit sending the work into the shop.

At the West Milwaukee shops alone there are over 400 d.c. motors ranging in size from 1 to 800 hp. This includes 10 portable welding machines and three stationary welders. To insure quick replacement in local emergencies there are on hand at all times about 25 spare armatures in the store department. Some signal department work is done such as rewinding switch machine motors. The only electrical work not handled here is car lighting, which is taken care of in a special shop nearby.

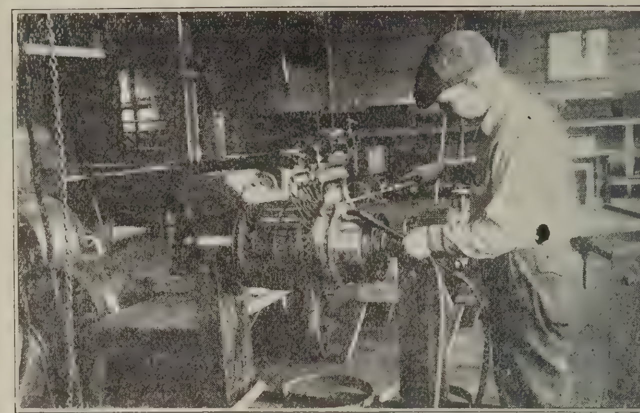
A recent report of savings (based upon labor and material costs only) indicates that this shop can save 50 per cent of the cost of new armatures and frequently 80 per cent of such cost. The savings are proportionately greater on the small headlight armatures where the commutators are salvaged at an expense of $2.00, or a saving per commutator of $8.00. Headlight field coils are repaired at a saving of $6.00 per coil. A material credit of $0.08 per lb. is realized on scrap brass and $0.10 per lb. on scrap copper. It can be conservatively stated that on headlight repairs alone an average net saving of over $600 a month, exclusive of overhead charges, is made by operating this repair shop. The total monthly saving, not including overhead expense, approximates $1,000. While this repair shop must properly bear its share of shop expense, store expense and general supervision, it is worth noting that very little, if any, of the overhead expense would be saved if the railroad did not operate this shop, and to that extent the savings listed approximate actual total savings. At 6 per cent this saving represents a capitalized profit of $200,000 which is much greater than the investment in repair facilities. Where there exists a large enough volume of work, as in this case, the paying possibilities of a well equipped electrical repair shop are attractive according to the shop supervisors at West Milwaukee.

Shop Equipment in Use

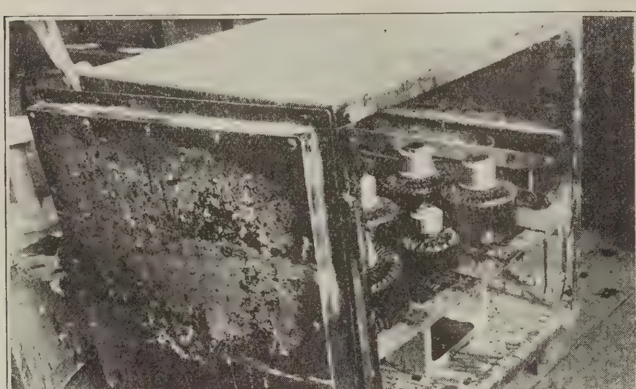
Headlight armatures are rewound at a work bench, using a simple shaft support while the winder laces them with Deltabeston magnet wire. Each coil length of wire for a single unit of the ring type headlight armature is cut to proper length in advance. The flat magnet wire used on Pyle-National Type-E armatures is also prepared in advance to the proper length and bent at right angles to make the slot connections on the commutator segments. The large armatures are stripped and rewound on special armature stands. In stripping, an oxy-acetylene torch is used to advantage in melting out the coil connections to the commutator leads.

Form wound coils are made with the aid of a Segur coil forming machine (Electric Service Supplies Co.) which facilitates the winding, also, of field coils. In using the Segur machine the correct number of turns per coil is first wound over two spools whose spacing is

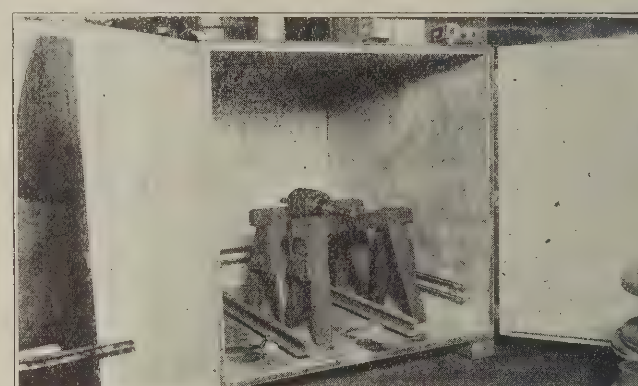
All Winding of Form Wound Coils Is Concentrated at This Bench Which Is Equipped with a Segur Coil Forming Machine



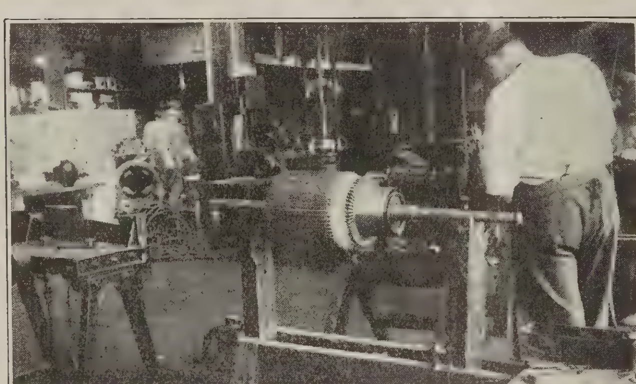
The First Step in Rebuilding an Armature—Melting Out the Coil Connections with the Aid of an Oxy-Acetylene Torch



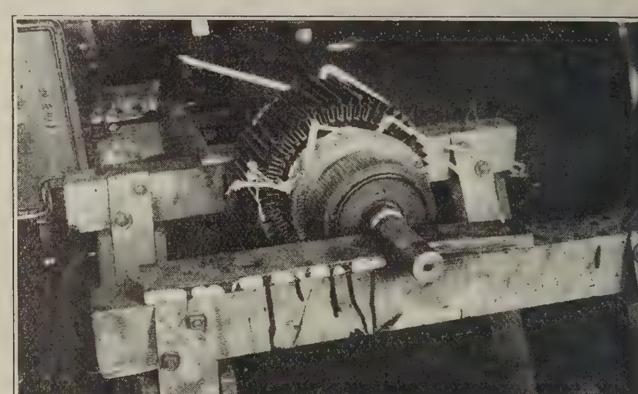
A 2-Kw. Electric Oven Is Used for Baking Headlight Armatures. The Oven Holds 24 Armatures



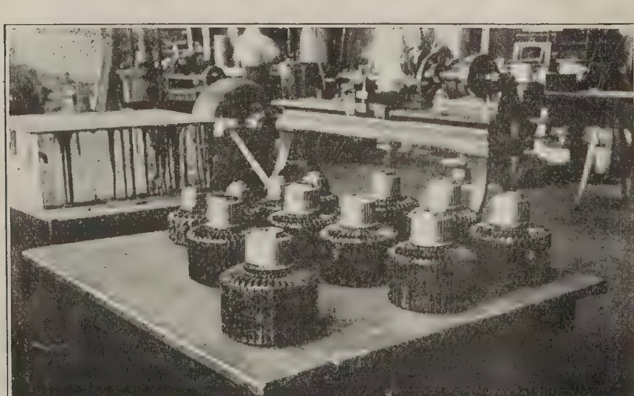
This 5-Kw. Electric Oven Can Accommodate the Larger Armatures—Locomotive Lagging Is Used for Insulation



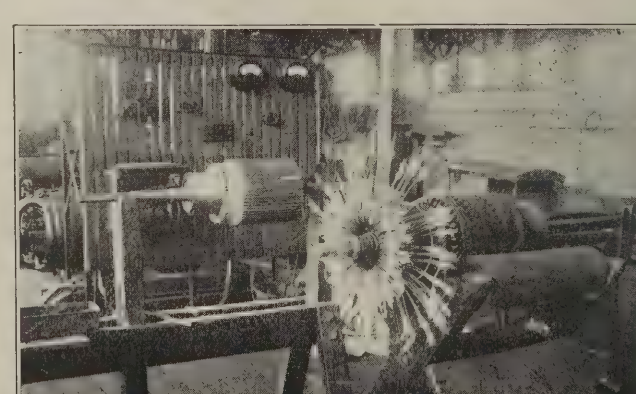
A Rebuilt Armature Ready for the Final Banding and Baking Operations



Where Space Permits Armature Slots Are Insulated with Mica on the Sides and Bottoms and Covered with Insulating Paper



Some Rebuilt Headlight Armatures Ready for Final Inspection

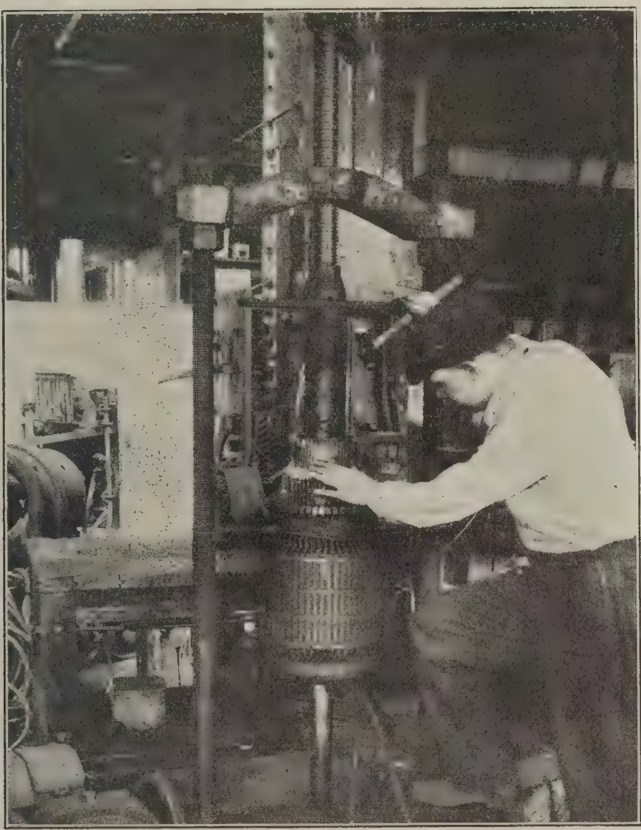


Armature Coil Leads Ready for Connection to the Commutator

adjustable by means of a threaded lead screw. The coil loop is then transferred with the spool support to the clamping jig which can be adjusted to the required coil pitch, where the coil is formed to the proper shape. A small taping machine is used to cover the individual coil wires before assembling the armature and also for taping headlight field coils. The latter are wound to the correct number of turns by a power operated coil winder equipped with a revolution counter. The coil forming machine and coil winder are practically one unit of the shop, being mounted on a separate bench with a lower deck for storing magnet wire.

Electric Baking Ovens Installed

Two electric baking ovens are installed, one for small headlight armatures, the other for larger motor and generator armatures. The small oven has a capacity of 24 armatures and is heated with four 500-watt Cutler Hammer resistance units. Each unit is independently controlled with a knife switch. The large oven measures inside 5 ft. by 5 ft. by 6 ft. and has ten 500-watt Cutler Hammer units controlled in steps of two units each. This oven is insulated with 1 in. locomotive lagging enclosed in sheet metal and can be used for temperatures up to 500 deg. Fahr. Truck loading is arranged for by two rails on the floor of the oven.



Vertical Press Used for Pressing Armature Shafts and Commutators

Armatures are heated to about 100 deg. Fahr. to remove all moisture before they are dipped in insulating varnish, and baked again for 10 hours, following which they are dipped in black finishing varnish and further baked for eight hours. Special efforts are made to thoroughly insulate the armatures of train control generators, because a ground resistance under five megohms may lead to trouble. For this reason all armatures used for this purpose are stripped and rewound to withstand an insulation test to ground of over five megohms. In ordinary headlight service the armatures are considered satisfactory if they show up at least as high as 1/10 megohm using a Standco 500-volt megohm-meter. After stripping the train control armatures, they are retreated to retain permanently their magnetic properties, rewound and retreated a second time, and dipped and baked a second time, following which they must show an insulation resistance above five megohms. With the continuous inductive train stop system used on the St. Paul, insulation resistance is of major importance in all of the locomotive circuits, due to the weak induced currents in the receiver coils and the vacuum tube amplifiers. When space permits, motor and generator armature slots are insulated with mica on the sides and bottoms and covered with a layer of insulating paper reinforced with cambric. This latter material is made of varnish cambric and paper woven together as one piece to reduce assembly labor. If there is not sufficient space in the slot, the mica is not used, the paper having an equivalent insulation value, but in other armatures the use of the paper eliminates the need of using double thicknesses of mica.

A vertical press enables shafts to be pressed out of and into armatures with little difficulty. This press is also used for pressing commutators onto armature shafts after assembly.

In order to have alternating current available for testing a.-c. motors, there is a motor-generator set connected to an auto-transformer that can be used to boost the voltage up to 500 volts 3-phase from 110 volts. A 220-volt shunt wound d.-c. motor drives the 110 volt, 15 kv.-a. alternator.

Radio Phone Between Locomotive and Caboose

A PRACTICAL demonstration of radio telephone communication between engineman in the locomotive cab and the conductor in the caboose of a 115-car freight train was conducted successfully on the New York Central on July 8, between Chicago and Elkhart, Ind., a distance of 95 miles. The test was conducted under the auspices of Committee 12, Radio and Carrier Current Systems, of the Telegraph and Telephone Section of the American Railway Association, in conjunction with the Zenith Radio Corporation. In addition to members of the committee, communication officers of various roads were present to witness the tests making a party of about 60. The radio apparatus performed in a satisfactory manner throughout the run and it was the consensus of opinion among the railroad officers present that such a facility could be used to advantage in freight train operation especially in mountainous country.

The train with a load of 4,600 tons, consisting of 115 cars (62 loads and 51 empties the majority of which were steel hopper cars), 1 business car, 1 coach and 1 caboose, left Englewood, Sixty-third street, Chicago, about 9 a. m., making the 95-mile run to Elkhart, Ind., in 4 hr. 32 min.

The first use of the radio telephone apparatus was

made while making up the train when the conductor talked with the engineman during the terminal air brake test and told him that there was not enough air at the rear end. At Pine, Ind., the engineman gave the conductor the number of the helper engine being attached and informed the conductor was he was ready to pull out. It was noted in this case that a period 26 sec. elapsed between the time the engine started and the instant the caboose began to move. Orders had been issued to make a stop at Millers, Ind. However, it was decided that the requirements could be met by throwing off messages at this point, whereupon the trainmaster in the caboose told the engineman to disregard the order to stop at Millers, but to call to the attention of the operator at that station that messages would be thrown off the rear end. This procedure being carried out successfully the train stop was eliminated. Other information regarding the operation of the train was passed back and forth from time to time.

Equipment Used

The radio equipment used in the locomotive—the same as that used in the caboose—consisted of a combined receiving and transmitting set with a dynamotor set operating from a 12-volt storage battery for the plate voltage and a 12-volt battery for the filament. Seven tubes, three for transmitting and four for receiving, were employed, a wave length of 115 meters being used. The antenna consisted of about 35 ft. of ½-in. brass pipe, which on the caboose was mounted on the frame work around the cupola, and on the engine above the cab roof.

The operation of the radio equipment was comparatively simple as was evidenced by the fact that the members of the train and engine crew, as well as a number of the railroad men present, had no trouble in securing satisfactory results. When ready for service the two sets are tuned; then by pressing a button in the caboose a howl was produced in the loud speaker in the engine cab. This signal was answered by the engineman by pushing a button and saying, "Engine 2561 talking, what do you want?" This started the conversation. The receiver and transmitter of each set are mounted together in a portable style with finger switch on the arm which is pressed when talking, this switch controlling the dynamotor which produces the transmitting voltage.

The howler signals which can be transmitted and received over the loud receivers at any time are used for calling a man to the phone, but can also be used to transmit the standard A.R.A. train operating signals such as for a "stop," "go-ahead," etc., that can be given by the signal air system on passenger trains. These howler signals can be transmitted and received successfully under most any ordinary conditions. However, the speech transmission or reception was considerably reduced when the engine or caboose was passing through a long heavy steel bridge.

The Antenna of ½-in. Brass Pipe Was Mounted Above the Locomotive Cab and Also Around the Cupola on the Caboose

Electric Express Passenger Locomotive, Chilean State Railways

Lighting Equipment for Gasoline Rail Cars*

Special Apparatus Developed Resembles That Used on Standard Coaches, But Is Smaller and Lighter

THE natural development of lighting equipment for gasoline rail cars has followed demands of the traveling public for the conveniences and comforts which are provided in other railroad conveyances.

The first gasoline rail cars—merely motor coaches applied to rails—retained the standard low voltage automotive type of lighting equipment. Improvements quickly followed, however, increasing the size of these cars and providing more adequate illumination. The consequent increased lighting load necessitated larger

Fig. 1—Generator Developed for Lighting Gasoline Rail Cars

capacity generators and batteries. Then came the adoption of standard railroad lighting equipment voltages with an attempt to retain the principle of the automotive equipment to the larger capacity generator but without success.

Experience has taught the railroads that conservatively rated generators, ample battery capacity and good regulation of both the battery charge and lamp voltage are necessary for economical and proper lighting of their cars. Consequently, builders of gasoline rail cars have turned to standard railroad car lighting equipment to fill this need. This equipment, however, is just a little larger and heavier than is actually required, so The Safety Car Heating and Lighting Company has developed a line of generators and regulation to exactly meet the requirements.

The Generator

The generator is four pole, shunt wound, and gives sparkless commutation for all speeds at which it is designed to operate. It is made in two sizes—

1-KW. (40 volts, 25 amperes) at 550 r.p.m.
2-KW. (40 volts, 50 amperes) at 1000 r.p.m.

The generator may be operated at three times the normal full load speed without injury when used with the safety generator regulator.

The magnet frame is a one-piece steel casting, finished smooth on the outside. The cast iron heads which carry the bearings are bolted to the magnet frame at each end. A hand-hole cover is provided at the commutator end of the machine for inspection purposes.

The poles are of the laminated type, fastened to the magnet frame by means of ample size bolts.

The field coils are wound with heavily insulated wire and are impregnated by the vacuum process with material which makes them oil-proof and water-proof. They are held in position by the pole pieces.

The leads are flexible rubber covered wire, soldered to the coils and securely taped for 6 inches before coming through the insulation.

The armature is form wound, with conductors having fireproof insulation. The coils are held in the core slots by hard fibre wedges; no band wires being used except at the ends, beyond the pole pieces.

The armature core is built up of transformer iron laminations, insulated after punching. They are assembled under heavy pressure between malleable iron plates at each end.

The commutator bars are of hard drawn copper with liberal wearing depth and ample area to carry the maximum output of the generator. The armature coils are connected directly to the bars. The mica insulation is of the best grade amber mica, having the same rate of wear as the commutator bars.

The shaft is made of high grade steel accurately ground to size.

The sprocket or coupling seat on the shaft is provided with standard S. A. E. taper and key seat with castellated locknut.

The bearings are the highest class annular ball bearings, of a type especially developed for this service. The bearings are mounted directly on the shaft, insuring ease of application and removal.

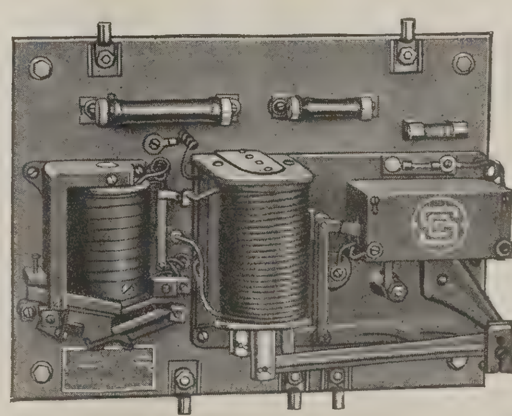


Fig. 2—Type K Generator Regulator

Ample space is provided around the bearings for lubricating grease. Grease grooves and felt washers prevent the entrance of dirt into the generator or bearings.

The brushes are of special high grade carbon which will not cut or gum the commutator. They are provided with flexible copper pigtails to give positive contact with the brush box. Each brush is provided with a separate

*Abstracted from a Bulletin Published by the Safety Car Heating & Lighting Co.

pressure spring of such design that the pressure on the brush is constant until the brush reaches the limit of wear. These springs are spiral, provided with a yoke so that the spring is set for the proper pressure before it is applied to the brush holder and needs no further adjustment; neither is there any danger of the spring being distorted in application.

Generator Regulator

The generator regulator is shown in Fig. 2 and wiring diagram in Fig. 5. The generator is controlled to give the proper battery and lamp current through changes in speed and load by the amount of current supplied to the shunt field. This field current is controlled by the resistance of the carbon pile *C* in series with the field. The resistance of this carbon pile is governed by the pressure exerted on it by levers which are operated by the plungers of current magnet *S* and voltage magnet *A*. The windings of *S* carry the total current output of the generator;—if the current output tends to vary from that which the regulator is set to maintain during the early stage of battery charging, the plunger of the coil *S*, through its lever, changes the pressure of the

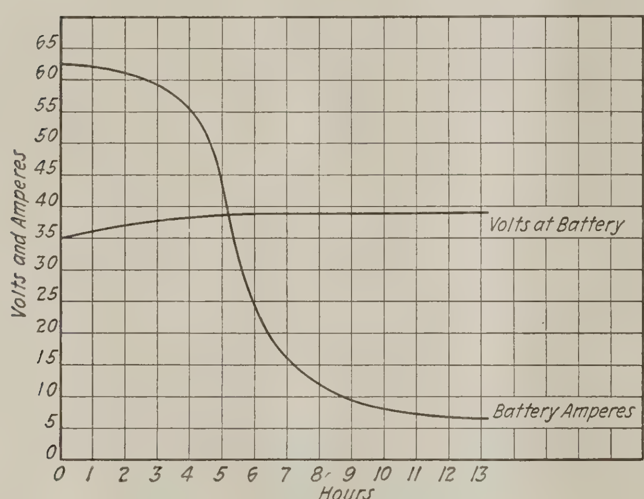


Fig. 3—Curve Showing Charging Current to a Car Lighting Battery with the Type K Regulator

carbon pile *C*, thereby reducing or increasing the field strength and holding the generator current to its proper value. If the voltage tends to rise above that for which the regulator is set to maintain, the plunger of the coil *A*, through its lever, reduces the pressure on the carbon pile *C* and holds the voltage to its proper value, thereby insuring reliable battery protection and adequate lamp supply.

The coil *S* is set to hold the current value at the rated output of the generator. The voltage coil *A* is set for a maximum voltage of 2.40 volts per cell, or 38.5 volts on a 16-cell equipment of lead batteries. With this as a maximum voltage, the coil *A* when effecting the regulation, prevents overcharging of the batteries since the current to the batteries will then automatically taper down to a low value as the batteries become fully charged.

The curve showing the charging current to a car lighting battery with this regulator is shown in Fig. 3.

As the output of the generator is regulated at its rated capacity by the series coil *S*, the generator cannot be overloaded either by lamp load or by charging an exhausted battery;—at the same time, the full output of the generator is available for battery or lamp load whenever it is needed. An equipment with this system of regulation will maintain service with a higher lighting

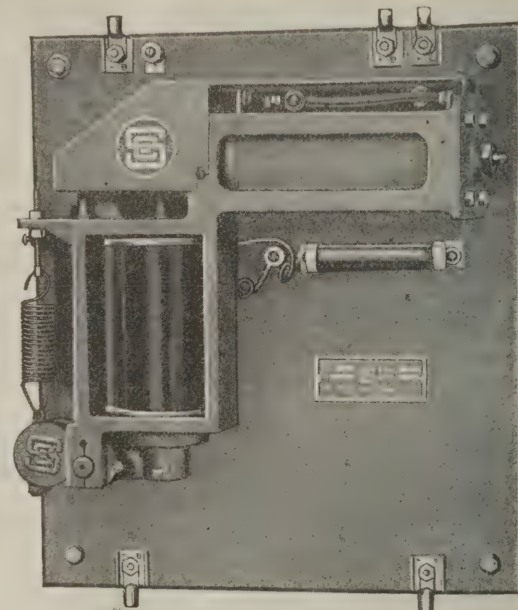


Fig. 4—Type G Lamp Regulator

load than an equipment with a system in which the regulator maintains only the battery current constant regardless of lamp load, assuming generators of the same given size are used with both equipments.

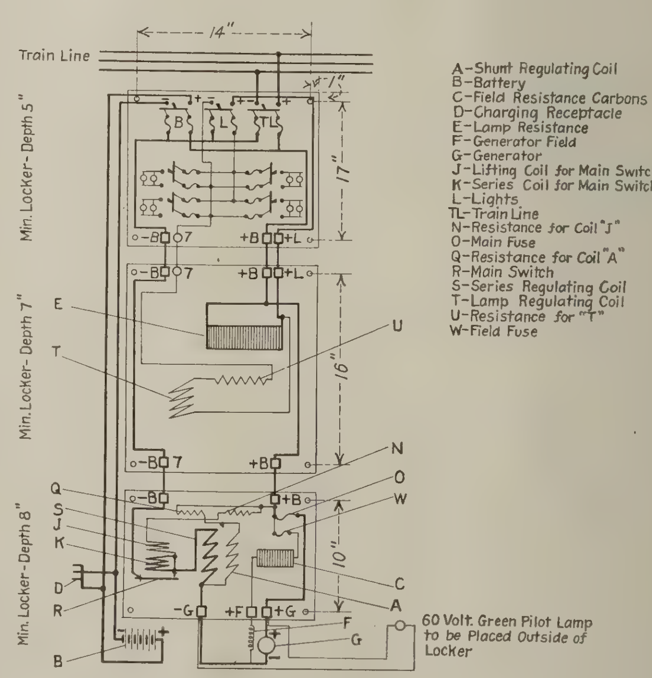


Fig. 5—Wiring Diagram of Generator Regulator Shown in Fig. 2

The automatic switch is of the closed magnetic circuit type with pivoted armature. It has a shunt lifting coil which, when the generator voltage equals the battery voltage, lifts the armature, and brings into action the series coil which holds the switch tightly closed and

assists in opening the switch when the generator voltage falls below battery voltage. Carbon contacts are provided to prevent arcing at the main brush.

Lamp Regulator

The Safety type *G* lamp regulator consists of a single pile of carbon discs in series with the lamps. These carbons are compressed by a movable back plate through the pull of the tension spring acting to compress the carbon discs through the solenoid core, and a vertically operating cam attached to the top of the core and bearing against the movable end plate. Friction at all points of contact is avoided by the use of ball bearings.

The action of the spring tends to pull the core of the solenoid in a downward direction and compress the carbons. Energizing the solenoid tends to pull the core in an upward direction and release the carbons. When the voltage on the lamps is normal the spring pull balances the solenoid pull. If the voltage goes above normal, the solenoid overbalances the spring and releases the pressure on the carbon discs, bringing the voltage back to normal again, when another balance is obtained. If the voltage drops below normal, the opposite action takes place.

The design is such as to give the high pressure for low drop when the lamps are fed from the battery, combined with sensitiveness of action to hold the voltage normal under varying conditions of generator voltage.

Long Island Tests for Insulating Varnish

THE work of repairing armatures so that maximum service may be secured from them necessitates the use of various kinds of varnish. All varnishes are not suitable for such work and the Long Island Railroad has found that it cannot safely rely on all of the claims made by different manufacturers. The road has, therefore, devised a series of tests through which different varnishes are put, before they are accepted. The tests which have been found useful in determining the kind of varnish best suited for armature repair work are given as follows:

Specifications for Testing for Insulating Varnishes

1.—*Materials Covered.*—These tests are intended for varnishes which are applied for brushing, dipping or spraying and are primarily for the purpose of providing electrical insulation.

2.—*Working Viscosity.*—The working viscosity shall be determined by immersing a sheet of bond paper 0.0025 in. thick and 4 in. by 20 in. in a clean sample of the varnish, which is free of air bubbles, to within 2 in. of the top, and then withdraw evenly and rapidly, and allow it to drain thoroughly in a vertical position. Then bake or air dry as required. Measure the thickness in mills at 2 in., 7 in. and 12 in. from point of immersion, ½ of the average of these measurements minus the thickness of the paper shall be known as the working viscosity.

3.—*Time of Drying.*—Specimens for this test shall be pieces of 0.0025 in. bond paper similar to one used in making working viscosity tests. The specimen shall be dipped once in the varnish, withdrawn rapidly and allowed to drain in a vertical position and either air dried or baked according to material to be tested. Baking temperature shall be 100 deg. C. Air drying temperature 25 deg. C. The thickness of the varnish shall be such that at a point 12 in. down on the strip the thickness shall be between 0.0044 in. and .0046 in.

Specimen to be examined every 30 min. to find the various times. Setting time, or that at which when pressed with finger mark will be made which is not obliterated by further flow (baking varnish to be now placed in oven).

Surface drying time when pressed lightly between thumb and finger in a 12 in. line shall not adhere.

Hard drying time at which sheet may be doubled and 2 in. by 12 in. marks pressed together without sticking.

Cracking time at which sheets when 2 in. and 12 in. marks are held together and sheet drawn taut over a ⅛ in. mandrel.

4.—*Dielectric Strength Test.*—Specimens for the dielectric strength test shall be prepared by dipping pieces thoroughly cleaned, smooth sheet copper or brass about 7.88 sq. in. and about 0.05 in. thick into the varnish.

Each specimen shall be dipped four times as specified in drying test, one in each direction in order to give a more uniform thickness of coating. The specimen shall be dried after each dip in the same vertical position in which it was dipped. The temperature and time of drying shall be as indicated in the time of drying test, for the stage as indicated as "hard dry."

The final thickness on each side of the specimen shall be between .0035 in. and .004 in.

The dielectric strength of the two films of varnish shall be determined by applying alternating potential to two circulating metal disks, 1.18 in. in diameter and with edges rounded to a radius of .25 in. which are placed in contact with the two sides of the specimens and directly opposite each other and under a pressure of approximately 1.1 lb. The potential shall be applied at a low value and gradually raised at a rate of approximately 500 volts per second until puncture occurs. Ten such punctures are to be made at various points selected at random on each specimen. In each test the thickness of the films of varnish is to be determined as near to the point of puncture as practicable.

The volts at puncture, the net thickness of insulation and the volts per mill of net thickness, shall be reported for each of the ten tests together with the average maximum and minimum volts per mill.

5.—*Water Absorption Test.*—The specimens used for water absorption test shall be brass rods .59 in. in diameter, 5.9 in. long and carefully rounded at one end to a radius of 1.295 in. These specimens after thorough cleaning shall be dipped three times into the varnish as prepared for the progressive oxidation tests so as to leave bare 1.18 in. of the rod at the end opposite the rounded end. Each coat shall be allowed to drain for one hour at room temperature and then baked for the time necessary to hard dry as shown by article No. 7.

They shall be immersed for 1.25 in. in distilled water at a temperature of 25 deg. C. and allowed to remain there for 24 hours. The voltage drop using a 110 volt a.c. sine wave circuit shall be measured immediately upon putting each piece in the water and again at the end of 24 hours. Should specimens break down when first tested they should be remade, after three attempts showing failure of each, the sample shall be considered as unsatisfactory. The figure indicating the ratio of the

voltage drop after 24 hours to that at the beginning of the test averaged for the three specimen shall be considered as the result of the test.

The temperature of the solution shall be kept at 21 deg. F.

Note:—A simple method is to connect a voltmeter between each rod in turn and one side of a 110 volt direct current circuit, the other side of the circuit being connected to the solution through any suitable piece of metal suspended in same. The resistance will be inversely proportioned to the deflection of the voltmeter pointer, that is, the smaller the deflection the greater the resistance. Failure of the material will, therefore, be indicated by a sudden increase in the deflection of the voltmeter point.

The resistance between each rod and the solution shall be measured once per day and the number of days elapsing until breakdown occurs shall be taken as the resistance of the varnish to that particular medium.

6.—*Heat Endurance Test.*—For the heat endurance test, a specimen shall be prepared as in section 4. After first removing material less than .5 in. from the edge, 7 strips shall be cut from the same edge, each .75 in. wide.

Six of the seven specimens prepared for this test shall be placed in a uniformly heated oven in which the temperature is maintained at 100 deg. C. within plus or minus 5 deg. C. A specimen shall be removed at the end of 50, 100, 200, 300, 400 and 500 hours respectively and together with the initial specimen shall be tested as follows at a room temperature of approximately 20 deg. C.

Each specimen shall be bent through 180 deg. over rods of ¼ in. cm., 3/16 in. and ⅛ in. diameters, respectively, beginning with the largest and using each time a part of the specimen which has not been previously bent. The diameter of the rod at which the first crack in the insulation occurs shall be noted and reported.

7.—*Oil Resistance.*—To test the effect of oil, use pieces cut from the dielectric strength test specimen after they have been punctured and measured. Immerse them halfway in transformer oil at a temperature of 100 deg. C. and note time of softening until film may be removed by pressure and drawing through thumb and finger. Also upon another piece the time required to cause blistering; this last piece should never be handled. The average of these two in hours shall be considered the oil resistances.

8.—*Ageing Test.*—Strips of muslin which have been treated with the varnish in a way similar to the preparation of the paper string in the drying test, shall be prepared and hung in the shop. A record shall be taken every month to note any deterioration due to ageing of the varnish.

9.—*Penetration Test.*—Muslin shall be folded over until it forms about 40 layers. A 3/16 in. water gage glass containing about 6 in. of the varnish to be tested will be placed with one of its ends on the folded muslin and allowed to stand in vertical position for 30 seconds. The depth of penetration of the varnish into the cambric will then be reported as the number of layers that the varnish has penetrated.

Public Address System Adapted to Control Train Movements

The first application of a loud speaking telephone system to convey instructions to switchtenders on the ground is believed to be that made recently at the St. Paul Union Depot, St. Paul, Minn, where the public address system has been installed for the directing of train movements into and out of the east approach to the terminal.

Enough volume is obtained without any speech distortion from this telephone installation to enable all of the switchtenders in the yard to receive the yard director's orders under the heaviest traffic interference. During the first shift, 14 switchtenders are employed with an average of 250 movements per shift, while a like number are used on the second shift when the number of movements averages 240. Four men operate the switches during the third shift which is called upon to handle about 99 movements in and out.

Essentially, the equipment, as furnished by the Graybar Electric Company, comprises 32 loud speaking projectors of the balanced armature type located on 30-ft. poles at various switching centers in the yard, a desk transmitter in the yard director's office, an amplifier for increasing the magnitude of the voice current, the current supply apparatus and suitable charging equipment. The amplifier, located in the yard director's office, is panel mounted and consists of one Type 17-B amplifier and two Type 9-A amplifiers together with associated control apparatus.

The transmitter serves to convert the sound waves into electric energy which passes on to the amplifying equipment.

The 17-B amplifier receives and amplifies the weak voice current obtained from the transmitter. It provides two stages of amplification and makes use of two vacuum tubes, having suitable controls for regulating each stage of amplification. The 9-A amplifier units receive their input direct from the 17-B amplifier. These amplifiers are both single stage, power amplifiers using two vacuum tubes operating on a "push-pull" principle and delivering a comparatively large amount of power at voice frequency without noticeably distorting the complex wave form of the voice current.

Four 6-volt storage batteries, connected as two 12-volt units, one being held as a reserve, are used for filament current supply. The plate circuit battery is built up of 180 lead storage cells in series, giving a maximum plate voltage of 380.

Canadian National Needs $31,000,000 from Public

In the estimate submitted to the Canadian Parliament this session as to the financial requirements from Parliament for the Canadian National as a result of 1926 operations, it was stated that $31,000,000 would be all that the House would be asked to vote, a decrease from the previous year of $19,000,000. Before the house committee on national railways and shipping last week Sir Henry Thornton, president of the C. N. R., gave the particulars of the probable result of operation this year. He estimates that the net income from operation this year will be $34,379,829, the estimate being based on last year's results.

Design of an Electric Baking Oven

Shop Made Apparatus Which Has Had the Test of Time and Has Given Entire Satisfaction

By Niels Hansen

Assistant Foreman Electrician, Southern Pacific Railway, Oakland, Cal.

IN any electrical repair shop where various kinds of armature and field coils are made, some sort of an oven for baking these coils after they have been dipped in baking varnish, or for drying out damp motors, armatures, coils, etc., is a necessary part of the shop equipment. The train lighting electric repair shop of the Southern Pacific Company located at West Oakland, California, is no exception. About ten years ago or shortly after the present train lighting building, which was described in the January issue of the *Railway Electrical Engineer*, was built it was found necessary to add a suitable bake oven to the gradually increasing amount of shop equipment and it fell to the lot of the writer to design one which is described in the following paragraphs:

Fig. 1 is a drawing of the oven giving the various dimensions. It is made out of oak of a substantial construction in a box like shape with hinged cover. The entire inside is lined with ⅛-in. sheet asbestos over which is a covering of No. 18 gage galvanized iron extending over the top edges and having all seams and joints hand soldered. The inside dimensions are—length, 37⅝ in., width 21⅝ in. and depth 29⅝ in., which is reduced to about 28½ in. when the cover is closed down. The drawing shows slightly different dimensions due to the fact that it just shows the wood construction and does not allow for the lining of asbestos and sheet iron.

The original idea was to design the oven as compact as possible and yet provide ample room to take care of our work for several years to come. The length was determined by the length of the axle generator armature having the longest shaft which was the Adlake Newbold. The width was determined by allowing ample room for two of the largest diameter armatures to rest side by side and the depth, by having sufficient room for two layers of armature coils or armatures which also gives plenty of room to hold any motor not over 28 in. high. To take care of baking 25 kw. General Electric Curtis turbine generator armatures which are used in the generator sets on our dynamo cars, ferry boats and at some small stationary plants provision was made in the oven by cutting out a 4 in. x 12 in. slot in the center of each end for the shaft to rest in and project through, the space above being filled by two pieces of hardwood cut to fit over the shaft and lined with asbestos on the inside. Ordinarily, however, these slots are kept closed by the slides shown in the upper right hand corner of Fig. 1.

The cover which is also lined with asbestos and No. 18 gage iron is hinged at the back and is balanced by a counterweight suspended on one end of a piece of

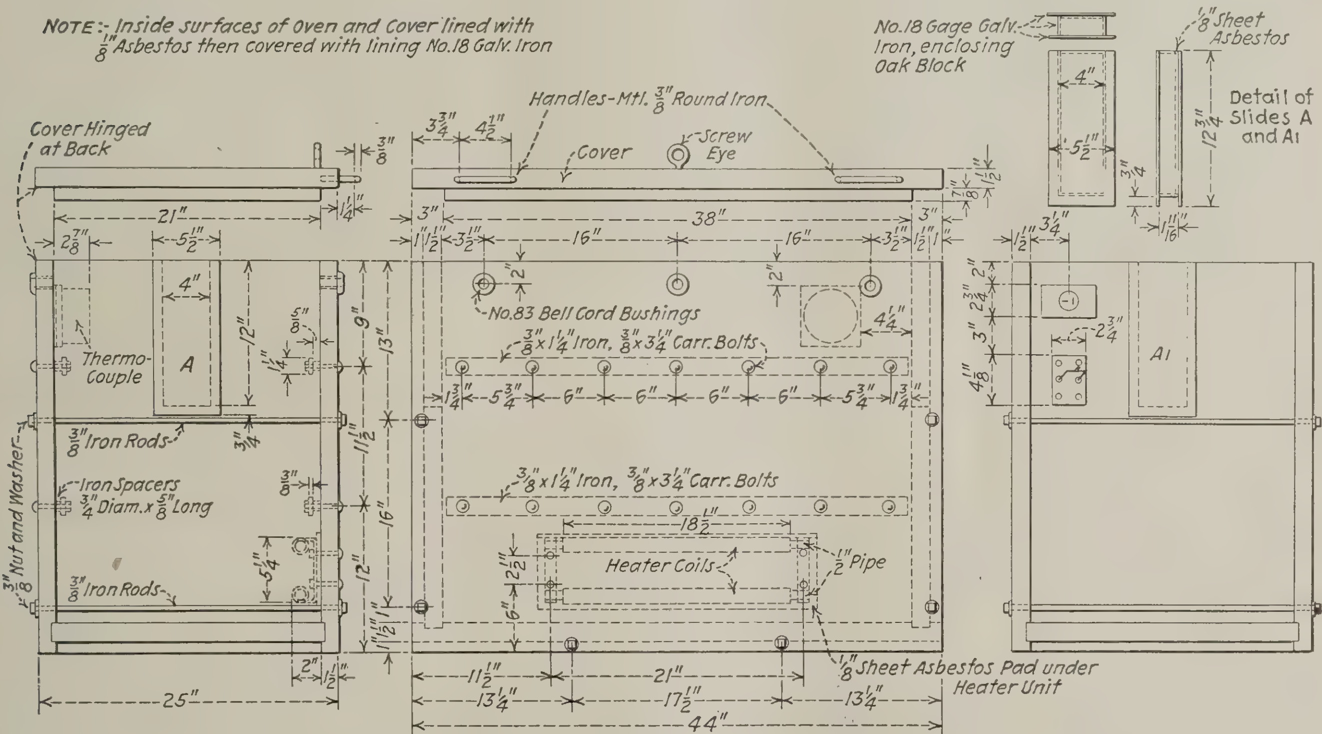


Fig. 1 Detail Sketch of Electric Coil Baking Oven Made in the Shops of the Southern Pacific

window sash cord which passes over a pulley supported from the ceiling next to the wall. The other end of the cord is fastened to a thimble which passes through the screw eye shown in the center of the cover near the front in the drawing Fig. 1.

For supporting the weight of the armatures and coils four pieces of 3/8 in. by 1¼ in. iron set edgewise are fastened to the back and front inside. The top pair are about 8½ in. below the top of the oven and the second pair are 11½ in. below the first. These supports extend the full length of the oven and are set out from the sides 5/8 in. by means of seven iron spacers ¾ in. diameter behind each one. Three-eighth inch by three inch carriage bolts pass through the entire sides and through the spacers bolting the supports up rigidly. A number of 5/8 in. square iron rods 21½ in. long are provided to lay across these supports and it is on these rods that the armatures actually rest on or the coils hang on. They can be moved about as desired.

A galvanized iron tray 1¼ in. deep made to fit over the entire bottom catches any drippings which may not have drained off on the coil dipping stand. This simplifies the work of cleaning the oven very much as the tray is just lifted out and scraped off and then replaced in the oven.

Three vent holes on the front and on the back sides near the top are provided for the escape of the gases formed during the baking of the varnish on the coils, etc. Number 83 brass bell cord bushings are fitted into each of these vent holes which make a clean hole and present a neat appearance.

Four pair of Payson Manufacturing Company No. 33 double wheel anti-friction casters are placed under the oven so it can be easily moved when necessary to clean underneath and in back of it besides they allow a 2 in. air space underneath.

The heating element consists of two coils, each wound with 130 turns of No. 19 Nichrome resistance wire, the ends of each being connected to brass terminal clamps on the ends of each coil. The turns are spaced about 1/8 in. apart over a winding space of about 17 in., not including the terminal clamps. The coils are 1 1/8 in. diameter and are wound on pieces of ½ in. iron pipe 21 7/8 in. long. These are insulated with two layers of 1/16 in. sheet asbestos wound on diagonally, in strips 2 in. wide with the edges just butting against one another.

The second or top layer is wound on in the opposite direction to the first so that the joints or seams cross one another. The strips of asbestos are first soaked in silicate of soda commonly known as "water glass" then wound on wet, secured in place with wires and then baked. This makes a hard, compact, heat resisting surface for winding the resistance wire on. The asbestos is cut back 1½ in. from each end of the pipes to allow the latter to be bolted to two U shaped brackets which support the coils. These brackets shown in Fig. 1 are made out of 1/8 in. by 1 in. band iron and are 5 in. wide by 1¾ in. high. An extra pad of 1/8 in. sheet asbestos is placed directly in back of the heating coils which are located in the center of the front side near the bottom of the oven.

The resistance of each coil is 24.5 ohms and they are normally connected up in multiple but can be put in series by means of the 15 ampere, 125 volt double pole, double throw knife switch located on the right hand end of the oven. On a recent test starting with the oven cold at 20 deg. C. and the coils in multiple in 1 hour's time the temperature rose to 83 deg. C., at the end of the second hour it was 96 deg. C., at the end of the third hour, 108 deg. C., and by the end of the fourth hour it had reached 120 C., with the thermostat cut out. Most of the coil baking is done during the day time. Occasionally, however, we get a rush job where it is necessary to keep the oven on all night. In such cases the d. p.-d. t. switch just mentioned is thrown in the down position throwing the heater coils in series at quitting time in the afternoon. The temperature of the oven is quite hot at this time and the heater coils in

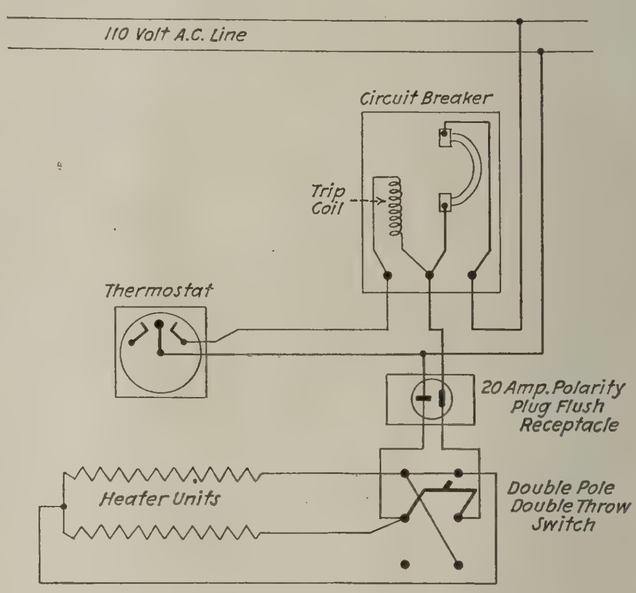


Fig. 2 Wiring Diagram of Control Circuits for Electric Baking Ovens

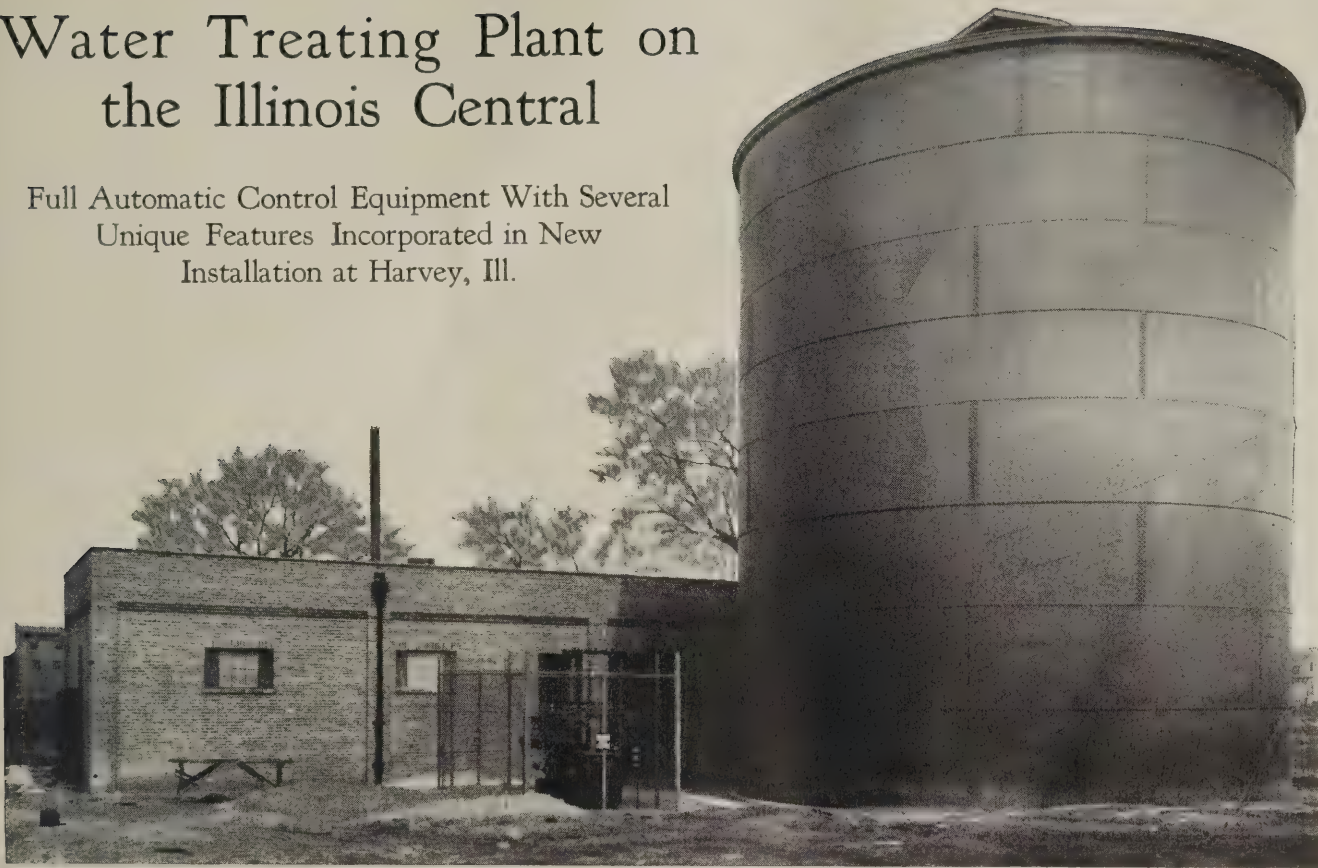
series will maintain a sufficiently high temperature during the night without the thermostat kicking out the breaker.

As a protection against excessive heat, a General Electric shunt trip breaker No. 110547-20-Type GG single pole, 100 amperes, 660 volt mounted on a 1¼ in. by 5½ in. by 11 in. slate base is provided and is controlled by a General Electric No. CR 2990 type CSA Form DL-1742164 thermostat. The circuit breaker is mounted on the brick wall about 6 ft. above the floor and just to the right of the oven. The thermostat is located inside the oven on the back side near the top as shown in the drawing Fig. 1. It is set to trip the breaker at a temperature of 110 deg. Centigrade or 230 deg. Fahrenheit. The various connections of the breaker, thermostat and heater coils are plainly shown in the wiring diagram Fig. 2.

Our armature coils are dipped and baked before and after taping so it is seldom that we find it necessary to bake the entire armature except the small Pyle types C, E2 and K and the General Electric headlight armatures which are dipped in varnish up to the commutator. The oven will hold 10 sets of axle light armature coils easily at one time if necessary and has proved plenty large enough to take care of all our needs.

Water Treating Plant on the Illinois Central

Full Automatic Control Equipment With Several Unique Features Incorporated in New Installation at Harvey, Ill.



New Continuous Type Water Treating Plant and Pumping Station at Harvey, Ill.

IN connection with the new Markham classification yard recently placed in operation on the Illinois Central at Hazelcrest, Ill., this road has completed a continuous type water treating plant and pumping station at Harvey, Ill. There are several electrical features about

Main Control Board From Which All Motors are Controlled Either Manually or Automatically

this new installation which illustrate clearly the flexibility and dependability of electric power for railroad pumping service. In fact, the plant is so designed that the electrical operation may, if it is desired, be made entirely automatic. The only attendance other than oiling and occasional inspection of the electrical equipment is the employment of a man to prepare the proper amounts of lime and soda ash for the water treating solution. This installation is particularly unique in that the control of water levels at six scattered locations and at different elevations is carried out effectively through electrical means from one central pumping station.

Water from the Calumet river is pumped by motor driven centrifugal pumps into the treating tank whence it passes after treatment into gravity type filters located in the machinery room of the pump house. Leaving the filters the water flows by gravity into a 50,000 gal. clear well below the building, from there being pumped into six roadside tanks located in three groups in Markham yard, the farthest tank being approximately five miles distant.

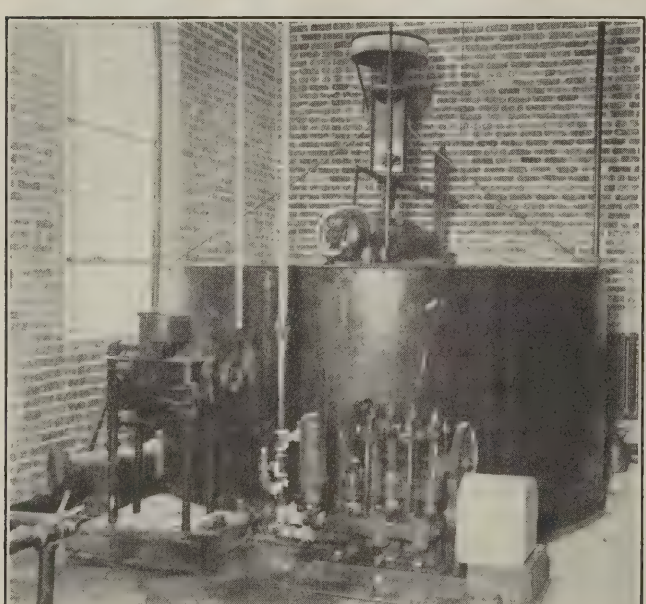
Pumping Units Furnished in Duplicate

Two motor driven centrifugal pumping units with a capacity of 750 gal. of water per minute each against a head of 75 ft. when pumping raw water from the river into the treating tank, and two motor driven centrifugal pumping units with a capacity of 750 gal. of water per minute each against a head of 125 ft. when pumping from the clear well into the roadside tanks, are provided. Each of the raw water pumping units is equipped with a 25 hp. Fairbanks-Morse slip-ring motor and each of the treated water pumping units is equipped with a 40 hp. Fairbanks-Morse slip-ring motor. These motors are all 40 deg. temperature rating, 440-volt, 60-cycle, 3-phase. The pumps are Fairbanks-Morse single stage, horizontal split case, enclosed impeller, bronze fitted, centrifugal type.

Both manual push-button and automatic float control of the Sundh Electric Company's type is employed for these pumping units. The float regulation is designed to start and stop one of the untreated water pumping units with a rise and fall of 2 ft. in the clear well, and to start and stop the other untreated water pumping unit in case a further drop of 1 ft. occurs in the water level in the clear well. In addition, this control is arranged by means of a transfer switch so that either of the two untreated water pumps can be set to act as a main pump or helper pump. The control arrangement provides, also, that either or both clear water pumps will stop when an emergency float switch recedes 6 ft. below the high water level in the clear well. This prevents any danger of these pumps burning out should the water drop below a safe operating level.

Novel System of Float Switch Control

The float regulation for the two clear water pumping units operates with a rise and fall of 6 and 8 ft. in the water level in three groups of water tanks at Markham yard. The elevation of the tops of these tanks is 80 ft., 89 ft. and 106 ft. respectively. The float control is so designed that when the water level drops 6 ft. in any of these tank groups, that one clear water pump will start, and if the water level continues to drop the other clear water pump will start when the water level is 8 ft., and



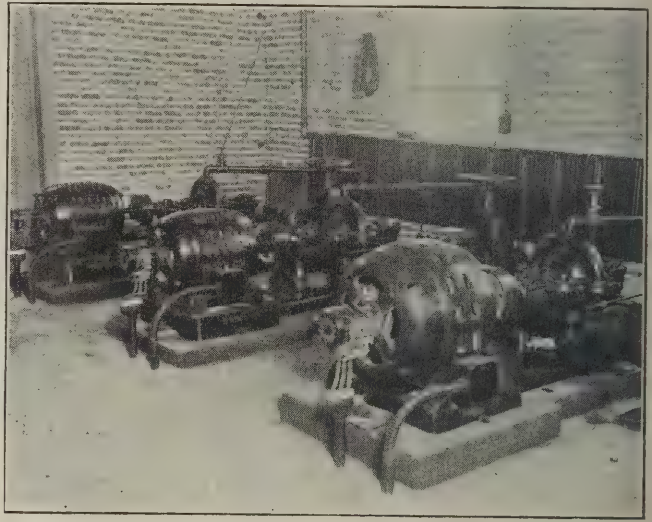
The 3 h.p. Motor Driving the Agitator in the Chemical Solution Tank and the 1½ h.p. Motor on the Triplex Pump are Controlled Automatically

both pumps will then continue in operation until that tank group as well as all the other tanks are full of water, at which time the pumps will stop automatically.

These float switches are termed the high and low level switches respectively. All high level floats are connected in parallel and all low level floats are similarly in parallel, there being two float switch control circuits running back to the main control board. There are three sets of float switches in service on these tank groups, in each case being installed on the roofs of the tanks in waterproof housings.

A check valve between each group of tanks prevents the flow of water from a tank of higher elevation to one of lower elevation. To prevent overflowing of tanks, a float valve is installed in the discharge line supplying each tank.

The float switch and control panel is designed to provide that one clear water pump shall assist the other clear water pump in case the latter pump cannot maintain the supply in the tanks. Added flexibility is obtained by a transfer switch which may be used to transfer the float circuits so that the two pumps may be alternated as main pump and helper pump. A cut-out switch is provided on the panel board to cut out the



Two Raw Water Pumping Units in the Rear With One of the Treated Water Units in the Foreground

automatic operation of either or both of the pumps in case push-button control is for any reason found more desirable, thus allowing manual operation of either or both pumps. The pumps are equipped with automatic air vents to allow prompt priming when operating automatically. The pumping units and control board are installed on suitable concrete foundations.

Operating in conjunction with the raw water and treated water pumping units just described are two small motors, one a 3-hp. Fairbanks-Morse driving an agitator in the chemical solution tank, the other 1½ hp. motor of the same manufacture on a small triplex chemical pump for the treating solution. The control circuits for the 1½ and 3-hp. motors and the two 25-hp. motors are arranged to provide for starting and stopping the former pair simultaneously with either of the 25-hp. motors. This is accomplished by suitably interlocking two small automatic starters controlling the agitator and chemical pump motors so that these motors start automatically when either raw water pump is started. Operation of the agitator motor independently of the raw water pump, when it is desired to mix up chemicals, is provided for by a knife switch on the control board.

Main Control Board

The control for each motor includes a three-pole, fused, main-line knife switch; an automatic starter consisting of a three-pole primary contactor electrically interlocked with two-pole secondary contactors equipped with time

limit adjustable dash-pots to provide correct time of acceleration; two inverse time limit overload relays; a dead phase relay, and a single pole, double throw, knife switch.

The latter, previously referred to as a cut-out switch, in one position puts the automatic starter under control of the float switch, in the open position makes the starter inoperable and in the reverse position controls this starter independently of the float switch. In addition to the starting and control apparatus a panel is provided with an eight-day clock, two vacuum gages on the suction line and two combination indicating and recording gages for the discharge line.

Transformers and Transformer Platform

A reinforced concrete transformer platform with a wire fence protection is located just outside the pump house and receives power from a 2,300-volt line of the railroad company's miscellaneous light and power system. This installation comprises three 50-kva. and one 2-kva. transformers including primary cut-outs for the transformers and primary and secondary wire racks for the wires leading to and from the transformers.

Power wiring circuits extend from the power transformers to a master switch box in the building and thence to the control board. From the control board they run to the two 40-hp., the two 25-hp., the 3-hp. and the 1½-hp. motors located in the machinery room of the treating plant.

Lights and Light Wiring

Lighting circuits extend from the lighting transformer outside the building to a master switch box and then to the lights in the treating plant. In the machinery room eight 60-watt Mazda lights are used. These are controlled from a distribution cabinet having separate control for two units of four lights each, as well as control for other lights. Four 60-watt Mazda lights are installed in the chemical storage room. These are controlled by a two-gang switch located at the door between the machinery and storage room in units of two lights each.

Three 60-watt Mazda lights are located in the chute enclosing the ladder outside of the steel tank and in the chute and head house on the top of the steel tank. One of these lights is placed over the top of the ladder in such a way as to best light it for men using it. All three of these lights are controlled as a single unit from the distribution cabinet referred to previously. A total of four 60-watt Mazda lights are installed, one above the outside of each door for lighting the steps, and are controlled by individual switches located at each door.

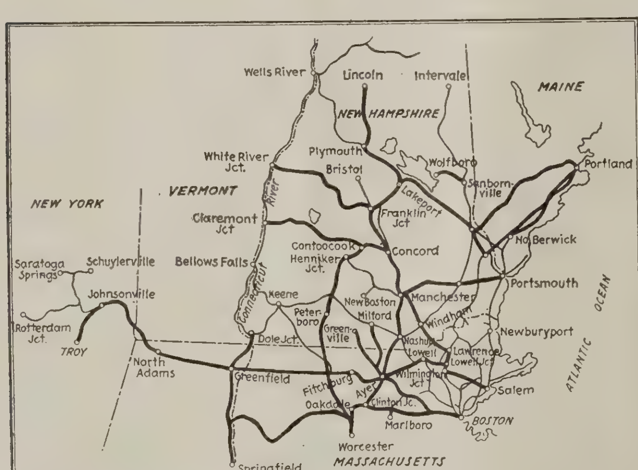
Express Passenger Train at Goschenen, Switzerland

One of the 73-ft. Rail Motor Cars Built for the Boston & Maine by the Osgood-Bradley Car Company

Gas-Electric Cars for Boston and Maine

Built for Operation on Long Runs in Main or Branch Line Service—Distillate Used for Fuel

On Tuesday, August 17, the Osgood-Bradley Car Company, Worcester, Mass., delivered a 73-ft. rail motor car to the Boston & Maine, the first car of an order of ten. The complete delivery of this order will make a total of 24 rail motor cars in service on that road. All of the ten cars are identical in their equipment, details of construction and power plant, except that two cars have a length over the body of 73 ft. ⅝ in., while the remaining eight have a body length of 61 ft. ⅝ in. The 73-ft. cars are intended for service on runs where the traffic does not require the use of trailers. They are a complete passenger unit in themselves, having both passenger and smoking compartments in addition to baggage space, as shown in the drawing of the floor plan of this car. The 61-ft. cars, however, are designed for trailer service and nine standard coaches are now being prepared for this service, with the same features of interior color design, car heating equipment and seats, together with mail compartments, baggage space and other details which are necessary for self-contained train service. The passenger compartment in the 61-ft. motor car serves as a smoker when trailers are used. The new cars are to be used on various divisions of the Boston & Maine on runs each approximating 200 miles a day. One of these cars is to be operated on a schedule that requires a daily run of 350 miles. In some cases the new equipment will replace other motor cars which will be assigned to less important runs while several of the new rail motor cars will replace steam locomotive train service. The map shows, in heavy black, the lines on which rail motor car routes are now in operation or will be when all the new cars are placed in service. At that time the Boston & Maine will be operating more than 2,500 train miles daily with rail motor cars.



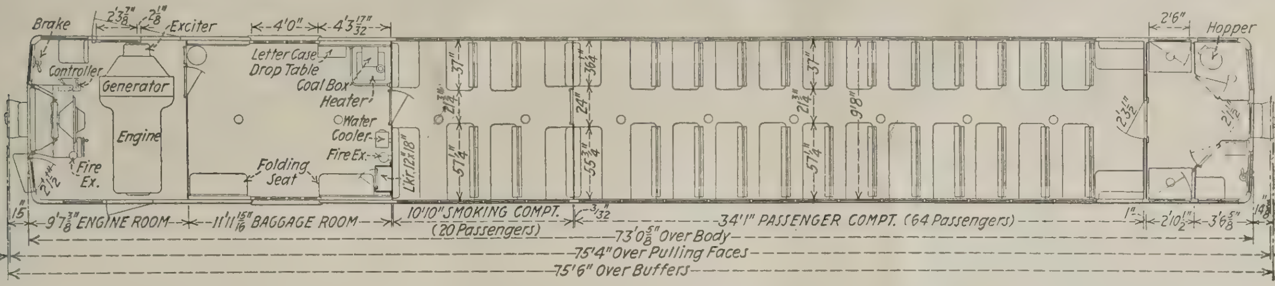
Map Showing the Boston & Maine Lines on Which Rail Motor Cars Are Operated

Both the 73-ft. and 61-ft. cars are equipped with the same type of power units and control apparatus. Owing to the fact that these cars are to be operated in main line traffic, the designers selected a power plant that would provide plenty of capacity to make a quick get-away from stations and also travel at a high rate of speed for short or long distances as required. Although the 73-ft. cars are not designed for trailer service, sufficient

The Wide Windows and Light Ceiling of the Passenger Compartment Add to the Attractiveness of the Car

capacity is provided to handle trailers when the traffic makes it necessary.

The power plant, which was furnished by the Electro-Motive Company, Cleveland, Ohio, consists of a six-cylinder Winton engine of new design, direct connected to a generator, manufactured by the General Electric Company, which has an output of 180 kw. at 1,000 r.p.m. The engine is designed to operate on a low grade fuel oil, such as distillate, the use of which is expected to effect a saving of about 50 per cent in price. The engine develops 275 hp. at 1,000 r.p.m. and has 7½ in. by 8½ in. cylinders. Two dual ignition Bosch magnetos provide an ignition service of four plugs to each cylinder. Duff carburetors designed to handle low grade fuel are applied on all ten cars. In case it is desired to use a higher grade fuel than distillate, such as gasoline, the only items that have to be changed are the carburetors and manifold. Provision has been made for starting the engine either by compressed air, electric starter, or by hand.



Floor Plan of the 73-ft. Rail Motor Car

View of the Front End of the 73-ft. Car Showing the Location of the Two Radiators

The truck under the engine room end of the car is used as the driving truck and is equipped with two General Electric motors, rated at 150 hp. at 600 volts. All ten cars are equipped to operate from either end, the operating cab at the rear end being located in the vestibule and entirely enclosed.

An interesting feature in the design of the power plant is that two radiators are employed for cooling. One of the radiators is of the automobile type and is located in the end of the car. The other radiator is located on the roof and consists of a series of pipes provided with fins to obtain increased radiation. A large fan draws air through the vents in the automobile type radiator and exhausts it through the radiator on the roof. Water in the radiator system, however, does not circulate through the roof unit unless the engine is running. This arrangement eliminates the possibility of the roof unit freezing up in cold weather while the car is standing idle. The hot water car heating system is also connected to the radiator system so that the end radiator can be kept warm in cold weather. This facilitates the starting of the engine, especially after it has been standing idle over night and also prevents freezing.

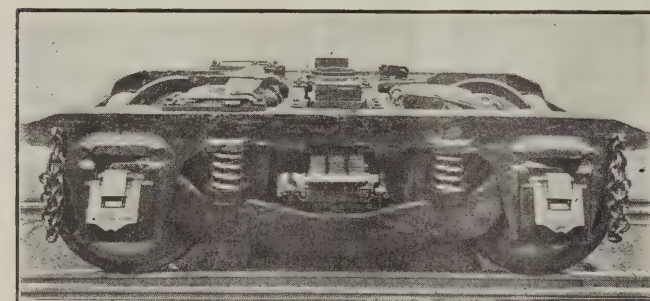
The two 73-ft. cars are equipped with Arcola heating units, while Peter Smith heating units are used on the eight 60-ft. cars. In both cases hot water is supplied to fin-type radiator pipes which are located near the floor along each side of the car in much the same manner as with the usual type piping. Approximately 5½ times as much radiation is obtained, however, with the fin-type piping as with the ordinary type. The hot water heating

Looking into the Operator's Cab—Both the 73-ft. and 61-ft. Cars Are Equipped to Operate from Either End

units are located in the baggage compartment, as shown in one of the illustrations.

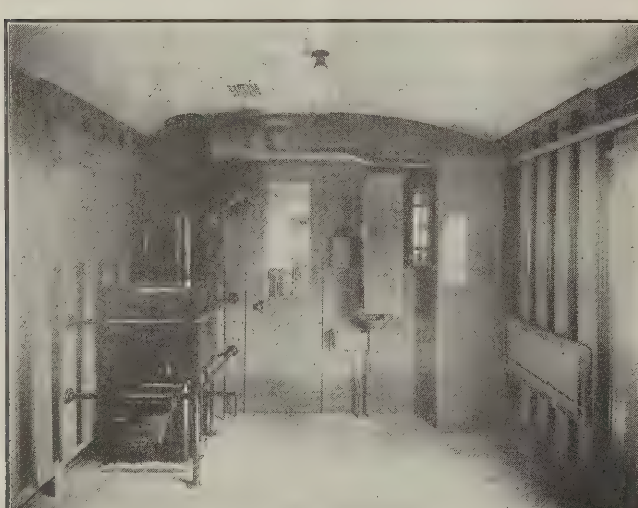
Body Design Contains Many Unique Features

The body design of the 61-ft. cars is the same as that of the 73-ft. cars except that the passenger compartment is used entirely for smoker service and the seats are all finished in Pantasote. The inside width is 9 ft. 8 in. and the width over the eaves is 10 ft. The height from the rail to the crown of the roof is 12 ft. 2½ in. The passenger compartments have a row of seats on one side of



Side View of the Motor Truck

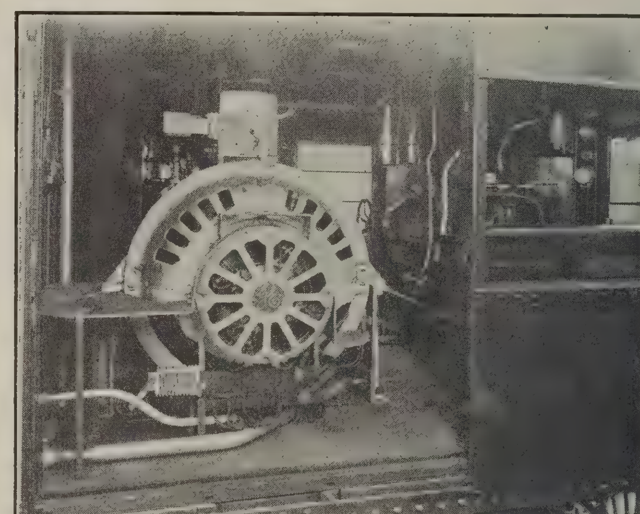
the car seating three persons and a similar row seating two persons on the other side with a 21¾-in. aisle space between. The toilet is located in the vestibule, as shown in the drawing, which provides additional privacy and also locates the hopper away from the trucks. The baggage room in both the 73-ft. and 61-ft. cars have the same general equipment, consisting of two folding seats, water cooler, locker for the crew, etc., the location of which in the 73-ft. car is shown in the drawing. The baggage room for the 61-ft. car, however, has a total



Interior of the Baggage Compartment of the 73-Ft. Car

length of 16 ft. as compared with 12 ft. for the 73-ft. car. This additional space permits the installation of an extra folding seat in the baggage room of the 61-ft. car. As shown in one of the illustrations, the ceiling is placed lower than is usually the case in passenger cars to give added efficiency in lighting and heating. The designers devoted considerable attention to making the interiors inviting to travelers. The use of narrow all-metal sash and small side posts has added much to the attractiveness of the car. This design provides an unusually large window area. The color scheme is a pleasing, leaf green enamel on the walls with the ceilings finished in light gray. The seats are of Heywood-Wakefield construction and in the rear passenger compartment are upholstered in plush dyed to a special tone of green to harmonize with the general color scheme. Pantasote covering is used on the smoking compartment seats. The baggage compartments are finished in a deep buff color. Duralastic flooring is used throughout. Central ceiling lighting, using rigid pendant lights with white diffusing shades, is applied in all the new cars. These fixtures, together with the reflecting surface of gray on the low ceiling, produce a well distributed light. Special attention has been given to the ventilation of cars and all are equipped with a type of ventilator manufactured by the Osgood-Bradley Car Company.

The cars are equipped with Commonwealth trucks and



Looking into the Engine Room—A Section of the Side of the Car Can Be Removed Which Permits Taking Out the Power Units for Repairs, If Necessary

have 33-in. wheels with 6 ft. between wheel centers on the trailer trucks and 7 ft. between wheel centers on the power truck.

Comparative table of general dimensions and weights

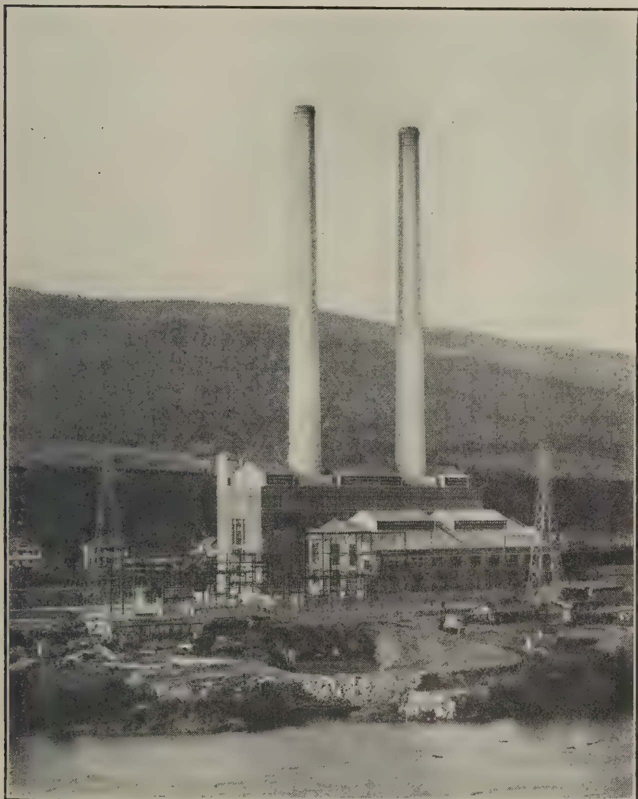
	61 FT. CAR	73 FT. CAR
Railroad-Boston & Maine. Builder—Osgood-Bradley Car Co.		
Length overall	63 ft. 4 in.	75 ft. 4 in.
Length of body over end frame	61 ft.	73 ft.
Length of engine room	9 ft. 6 in.	9 ft. 6 in.
Length of baggage compartment	16 ft.	12 ft.
Length of passenger compartment	28 ft. 11 in.	34 ft. 1 in.
Length of smoking compartment	....	10 ft. 10 in.
Length of rear vestibule and cab	5 ft. 4½ in.	6 ft. 4½ in.
Width over side sills	9 ft. 10 in.	9 ft. 10 in.
Height overall	12 ft. 7 in.	12 ft. 7 in.
Height, rail to top of roof	12 ft. 2½ in.	12 ft. 2½ in.
Height, rail to top floor	4 ft. 4 in.	4 ft. 4 in.
Truck wheel base	6 ft. trailer 7 ft. motor	6 ft. trailer 7 ft. motor
Truck centers	43 ft. 6 in.	55 ft. 6 in.
Diameter of wheels	33 in.	33 in.
Seating capacity, passenger compartment	54 ft.	64 ft.
Seating capacity, baggage compartment	11	4
Seating capacity, smoking compartment	....	20
Total seating capacity	65	88
Engine, h.p.	275 hp.	275 hp.
Fuel	Distillate	Distillate
Total weight of power unit with appertenances	30,000 lb.	30,000 lb.
Total weight (light)	90,000 lb.	100,000 lb.

The Virginian Traction Power Station

Plant Burning Powdered "Bone" Coal Will Supply Power for Entire 134 Miles of Electrified Section

THE electric haulage of coal trains, recently inaugurated by the Virginian Railway Company, constitutes, in respect to size of train unit operated, over adverse grades, the heaviest concentration of power on a moving train ever undertaken.

The electrification when completed this Fall will extend from Mullens, W. Va., to Roanoke, Va., a distance of 134 miles, and will include the heavy grade portion of the railway where it crosses the Appalachian Mountain system.



General View of the Exterior of the Plant

The maximum yearly tonnage for which apparatus is installed is 12,500,000 tons of coal, or 17,500,000 gross tons (cars and lading eastbound, with a small additional amount of manifest tonnage). The system is laid out to take care of a maximum day's traffic of 60 per cent above the average day.

A steam power plant has been built for this operation on the New River at Narrows, Va. The selection of site was determined by considerations of an adequate supply of condensing water, nearness to center of gravity of load, suitability of the location from the physical standpoint, and convenience for housing the operating forces in an established community.

The plant contains four 3-phase, 11,000-volt, 25-cycle, turbo-generator units, having a continuous rating of 10,000 kw. at 80 per cent power factor, with five 1521 hp. cross drum boilers, equipped to burn pulverized fuel. The power house is designed to permit of extension ultimately to include seven turbo-generator units and nine boilers. The generator voltage is stepped up through four 10,000 kv.-a. transformers to 88,000 volts for single phase transmission.

Power Plant Building

The power plant building is constructed of brick and concrete with structural steel columns and floor beams, and with roof of special heat-insulating concrete slabs covered with zinc shingles. The boiler room is 217 ft. long, 62 ft. wide and 91 ft. in height, giving room for six boilers, five of which are installed. The boiler ash pits, pulverizing mills and feed water heaters, are located at ground level. A mezzanine gallery, 23 ft. above the lower floor provides space for the pulverizer exhausters, the feeder blower fans and future coal drying units. The main operating floor is located 36 ft. above the lower floor. A mezzanine gallery is located at the rear of the boilers, 12 ft. above the main operating floor and provides access to the rear of the boilers for the removal and replacement of tubes. The ground area occupied by the boiler house building is 13,500 sq. ft. or 1.48 sq. ft. per boiler horse power, and 0.34 sq. ft. per kw. of generator rating. The boiler house contains 32,800 sq. ft. floor area of 3.6 sq. ft. per boiler horse power, and 0.82 sq. ft. per kw.—all allowances including space required for the pulverizing units as well as that required by the boilers.

Interior of the Turbine Room

The floor area of the turbine room is 11,500 sq. ft. thus providing 0.29 sq. ft. per kw.

The electrical bay has two floors above the ground level and provides space for the high tension bus and switch gallery, the switchboard control gallery, a machine shop, tool room, storage battery room, toilets, and administrative offices.

A basement under the turbine room and electrical bay, 32 ft. below the ground floor, provides space for condensers, circulating pumps, condensate pumps, boiler feed pumps, house service pumps, filtration plant, and storage space for plant supplies.

A mezzanine gallery 18 ft. below the ground floor provides space for possible future reactance coils for the main turbo-generators and for a 440-volt switch gallery.

Two stacks are provided, of reinforced concrete, which are carried on and directly bonded into concrete mats at the roof of the boiler room. The stacks are 25 ft. 8 in. outside diameter at the bottom and 16 ft. 0 in. inside diameter at the top, and rise 285 ft. above the concrete footings, making a total height of 376 ft. above the bottom of the ash pit.

Boiler Room Equipment

The plant has been designed for the use of "bone" coal, with provision for burning the high grade bituminous coal from the mines served by the Virginian Railway Company, or a mixture of the two.

It is expected that the total annual net output of the plant will be approximately 120,000,000 kw.-hr., and that the average daily fuel consumption will be approximately 390 tons of "bone" coal, or 275 tons high grade bituminous, or 320 tons of a 50 per cent mixture.

Boilers are of the cross drum horizontal water tube type, built for 325-lb. pressure. They are arranged in a single row, with independent settings extending from the lower boiler room floor upward 62 ft. to the top of the boilers.

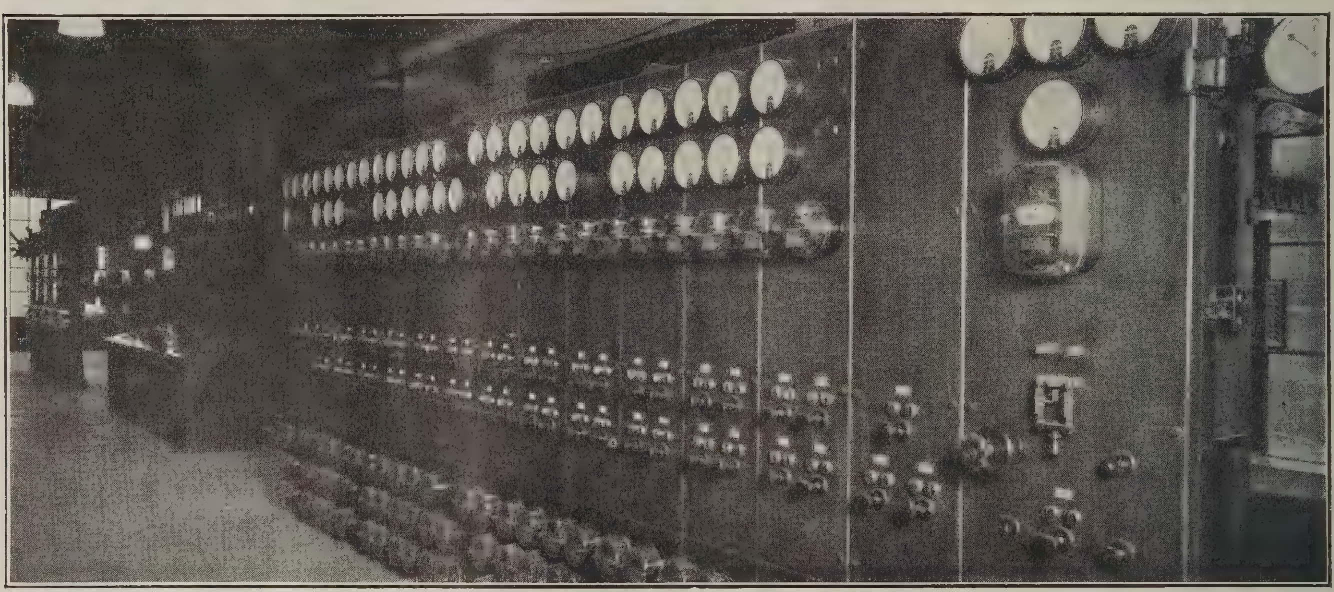
The boilers, superheaters, and pulverized fuel firing facilities are located from 40 to 62 ft. above the lower boiler room floor. An operating gallery has been provided, located 36 ft. above this lower floor so arranged that the operating forces have complete control of the boiler operation from one level.

Water screens are provided, designed to prevent formation of slag, and to allow operation with high CO_2 content of furnace gases.

The refuse resulting from the combustion of pulverized fuel is by reason of the cooling action of the water screens, a finely divided granular ash. This refuse is carried away from the boiler by a sluiceway into the river.

In addition to the usual safety valves, water columns, blow-off valves, gages, etc., each boiler is equipped with a feed water regulator designed to retard the flow of water into the boiler on sudden increase of load until conditions are equalized, after which the feed water is fed at the rate of steam flow. These regulators have an indicating device so that the operator of the boiler room floor may determine if the regulator valve is functioning properly.

A control has been installed for regulating the supply of fuel and air for varying loads, consisting of a master switch actuated by steam pressure in the saturated boiler header, fitted with a recording gage to register the variations in boiler header pressure, and with a motor driven electrical contactor so arranged as to send electrical impulses to the control equipment, and designed to increase the flow of air and coal on a drooping pressure and to decrease it on a rising pressure.



At the Back Is Shown the Regulator Switchboard, Next to It the Bench Board and in Front the Auxiliary Power Switchboard

Turbo-Generators

Four main power units have been installed, each of 10,000-kw. capacity, 25 cycles, 3 phase, 11,000 volts, having direct connected exciters. One 300-kw. auxiliary turbo-generator is provided.

The turbines are connected through a pin type flexible coupling to the generators, each of which is designed for a continuous full load rating of 12,500 kv.-a. at 80 per cent power factor. A 125-kw., 250-volt direct connected exciter is mounted at the end of each generator.

The 300-kw. turbine is of the impulse type and is direct connected through a reducing gear to a 3-phase, 440-volt, a.-c. generator; a 100-kw., 250-volt d.c. generator; and a small d.c. generator supplying excitation to the a.-c. machine. The 440-volt, a.-c. generator supplied power for the operation of the auxiliary equipment during the starting up of the power plant, and is available for special service during regular operation. The 100-kw., d.-c. generator is provided to supply excitation to any one of the main

units in the event of failure of the direct connected exciters furnished with them.

Each turbine has a surface condenser, with circulating water pump, a two stage air ejector, and a condensate pump.

The boiler feed water system consists of bleeder heaters at each of the turbines, two open water heaters, three turbine driven boiler feed pumps and a loop system of boiler feed piping between the pumps and the boilers.

Switching and Electrical Connections

One phase of each generator is connected to the primary of a 10,000 kv.-a., single phase 9800/88000 volt step-up water-cooled transformer. The connections are arranged for normally operating each generator and corresponding step-up transformer as a unit. A three-phase 11,000-volt bus is provided for synchronizing and for supplying power to the station auxiliary transformers, which is connected through oil circuit breakers to connection points between each generator and its corresponding step-up transformer. Each generator can be isolated by a set of knife switches, and a horn gap switch is provided on the primary side of each transformer, capable of breaking the magnetizing current of a transformer. This arrangement makes it possible to operate a generator when the corresponding step-up transformer is out of service for inspection or repairs, and allows the operation of the maximum number of transformers, in order to thereby keep the step-up impedance low, at times when economical operation dictates a smaller number of generators.

The Relay Board

Each step-up transformer is connected on the secondary side, through an oil circuit breaker to the 88 kv. bus, which is divided into two sections by a switch, with two step-up transformers connected to each section. The two west transmission lines are connected through oil circuit breakers, one to each section of the 88 kv. bus, and the two east transmission lines are similarly connected. The middle point of each 88 kv. transformer coil is connected through a disconnecting switch and neutral bus, to a neutral ground resistance.

The arrangement of bus sections is such that with any 11 kv. bus section and the corresponding 88 kv. bus section out of service, it is still possible to keep in operation two generators, two step-up transformers, two auxiliary transformers, one step-down transformer of the Narrows step-down substation, the water rheostat installation and one transmission line. Or the same amount of apparatus may be kept in normal operation while one generator, through separate bus sections, is used to independently energize one transmission line for test purpose.

11,000 Volt Bus and Connections

From the generator terminals, insulated copper cables run in fibre ducts to the current and potential transformer room, where connection is made to copper bars which in turn are connected to insulated lead covered copper cables which lead to the step-up transformers. From the above mentioned copper bars, connections are carried up through the floor to the 11,000-volt oil circuit breakers. From these breakers, connections are carried down into the current and potential transformer room, and up to the 11,000-volt bus.

Electrical Operating Gallery

The electrical operating gallery contains the generator and exciter field rheostats, exciter, field and regulator board, main control instrument and relay board, auxiliary power control instrument and relay board (vertical) battery, charging and control power panels, lighting panels, graphic watt-meter panel, and temperature indicating and transformer alarm panel. A small balcony projecting into the turbine room allows a view of the turbine room and provides space for the power director's desk in front of the control bench board. The main control and instruments are arranged on seven desk and vertical panels facing north and the main relays and watthour meters on seven corresponding vertical panels facing south, the space between the rears of the two boards allowing for access to wiring and being closed off by doors.

Each generator has mounted on the shaft a 125-kv. 250-volt exciter. A 100-kw. 250-volt spare exciter is mounted on the same shaft with a 300-kw., 80 per cent power factor, 25-cycle, 3-phase, 440-volt generator and driven by the 300-kw. steam turbine. The field, exciter, and regulator board includes one field and exciter panel and one voltage regulator panel for each generator and one panel for the spare exciter. A 250-volt bus allows the spare exciter to be used to supply field current to any generator in case the direct connected exciter is out of service. The generator field switches are electrically operated from the main control bench board. A rheostatic type voltage regulator is provided for each generator and regulates the generator voltage by cutting generator field resistance in or out by means of a motor operated field rheostat. Each generator is independently regulated by a separate regulator, the regulator receiving potential from a generator potential transformer connected across the traction phase. The regulators are compensated to give a drooping characteristic with increase in generator wattless current, thereby insuring parallel operation, and to give a rising characteristic with increase of watted component of generator current, thereby compensating for drop due to step-up trans-

former impedance and for part of the transmission line drop. The compensation current connections are from current transformers in the generator leads.

Control Power

The control power for circuit breakers is 220-volt obtained from a storage battery which is charged by two motor generator sets, one of which is kept floating on the buses at all times, keeping the battery fully charged. A feeder panel contains 12 fused knife switches, arranged so as to sectionalize the supply of control power that any fault in the control system may be isolated without any interruption to any essential service.

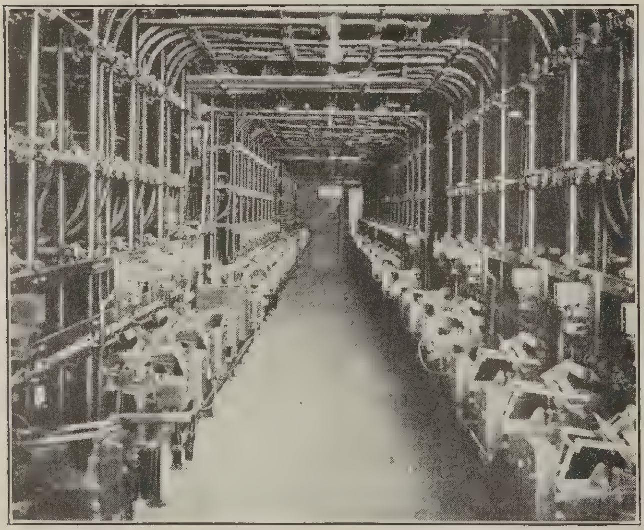
Auxiliary Power

Three auxiliary transformers are connected to the 11,000-volt bus through three oil circuit breakers, and are each 1200 kv.-a. 11,000/440-volt 3-phase. The entire load can be carried by two transformers, leaving the third in reserve.

A further source of auxiliary power is the 300-kw., 440-volt, 3-phase turbine driven generator previously described.

Solenoid operated oil circuit breakers are used for connecting the auxiliary transformers to the 440-v. bus and also for the 440-v. feeders.

Since the available short circuit current from two of the auxiliary transformers is greater than can be safely ruptured by the usual industrial motor starting equipment, the circuit breakers at the 440-volt bus are depended upon for protection against short circuit. In most cases a single circuit breaker feeds only a single motor, or two motors which must be operated or shut down together. Across the line starting is employed generally, the circuit breaker being closed or opened by push button control located at the motor. Circuit breakers having push button control cannot be closed from the electrical operating gallery, but all circuit breakers may be opened and locked open from the electrical operating gallery.



Auxiliary Power Bus and Oil Circuit Breakers

For starting equipment with holding coils, direct current is used for the coils in order to prevent the opening of equipment of inadequate rupturing capacity due to low voltage at time of short circuit.

The circuit breakers are opened automatically by overcurrent relays with definite and inverse time limit characteristic.

Protective Features

The 11-kv. oil circuit breakers and the 99-kv. transformer oil circuit breakers are not automatic on overload. Protection against internal fault in any generator, or transformer of 1,200 kv.-a. and larger, is accomplished by differentially connected current transformers and over current relays. In case of generator or step-up transformer internal fault, the connections are such as to simultaneously open the generator 11,000-volt oil circuit breaker, the generator field circuit breaker and the transformer 88-kv. oil circuit breaker. Internal fault on one of the 1,200 kv.-a. transformers will open simultaneously the 440-volt and the 11,000-volt auxiliary transformer circuit breakers. Internal fault on one of the 3,750 kv.-a. step-down transformers will simultaneously open the tie circuit breaker and the 88-kv. circuit breaker connected to that transformer.

The Outdoor Step-Up Station Located Alongside the Plant

A 220-ohm resistance connected between the step-up transformer neutral bus and ground limits to 200 amperes maximum the current in case of a grounded transmission line. Each 88-kv. transmission line oil circuit breaker is opened automatically in case of a ground on its line by a low energy over current relay so connected in the current transformer secondary circuits as to receive current only in case of ground. Over current relays open the 88-kv. transmission line circuit breakers in case of transmission line short circuit.

The water rheostat circuit breakers and the 88-kv. circuit breakers feeding the step-down station have short circuit protection by over current relays.

Excessive temperature, failure of water supply, or pressure relief diaphragm failure on any transformer will ring a bell on the electrical operating gallery and operate an annunciator drop, indicating which transformer is involved.

Outdoor Transformer and Switching Station

The outdoor transformer and switching station includes auxiliary and lighting transformers, main step-up transformers, and the 88-kv. transmission line lightning arresters. It also includes the step-down transformers for feeding the trolley at Narrows. The 88-kv. oil circuit breakers are all 400-amp. two-pole solenoid operated. Disc insulators and copper cable are used for buses and most connections. Copper tubing is used for the step-up transformer connections in order to obtain rigidity. The 11,000-volt transformer connections from the power plant are, for the step-up transformers, lead covered single conductor varnished cloth insulated cables run in concrete protected fiber ducts, and for the auxiliary transformers, three conductor lead covered varnished cloth insulated cables run in steel conduit.

The disconnecting switches used for isolating the tie circuit breakers and water rheostat circuit breakers are of the underhung, hookstick operated type. All other outdoor disconnecting switches are upright mounted, mechanically operated through bell cranks, rods and handle at ground level. The 88-kv. switches are horizontal opening, double break, and the other mechanically operated switches are vertical opening, single break. Disconnecting switches which may have to break transformer magnetizing current are provided with horn gaps, and all horn gap switches are located above adjacent apparatus and connections in order to avoid short circuits from gases produced by arcs.

Two 88-kv. electrolytic lightning arresters are provided, one for the two west transmission lines and one for the two east; each arrester consisting of three tanks, transfer switch, impulse gaps and two sets of horn gaps, one set for each transmission line.

The four main step-up transformers are 10,000 kv.-a., 9,800 to 88,000 volts, 25-cycle single phase oil insulated water-cooled. An additional full capacity tap gives a ratio of 9,310 to 88,000 volts.

The transformers are designed to carry 200 per cent load for five minutes following 150 per cent load for one hour without exceeding safe temperature and will withstand without damage a short circuit on the secondary terminals with normal voltage maintained on the primary terminals, providing the duration of the short circuit is not sufficient to cause injurious heating. Each transformer has an inherent reactance of approximately 8 per cent at normal rating.

Each of the water cooled transformers is equipped with a water flow indicator with loss of flow alarm contact, a dial indicating thermometer with excess temperature alarm contact, and a pressure relief diaphragm with target indicator and alarm contact.

Oil pumping and filtering is provided for by a motor driven blotting paper type filter press.

Regeneration

The electric locomotives used are of the split-phase type in which the 12,000 volt single-phase power from the trolley is stepped down through a transformer on the locomotive and converted to three phase for the traction motors by means of a synchronous phase converter. This type locomotive provides automatic change from motoring to regeneration, as the grade changes without action of the engineman other than a movement of a lever operating the transformer balancing switch.

The regenerated power is returned to the substations and finally to the Narrows Power Plant where excess power is absorbed by a water rheostat consisting of electrodes immersed in the river.

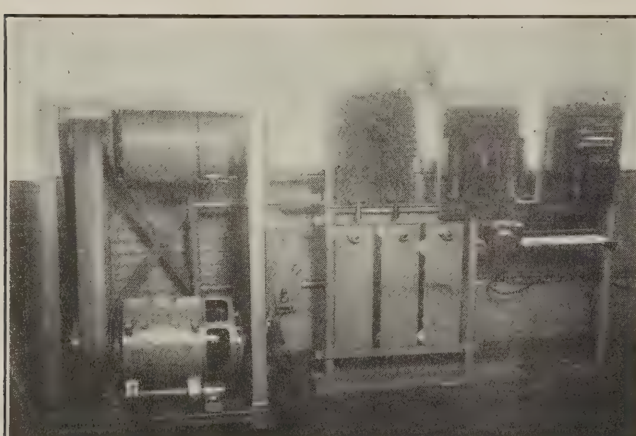
The electrical apparatus was furnished by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., as a part of its general contract for apparatus for electrification of the railway.

The power plant was designed and constructed by Gibbs & Hill, consulting engineers, New York City, as a part of their work as engineers of the electrification, under the general supervision of Mr. H. Fernstrom, chief engineer of The Virginian Railway and Mr. Hugh Pattison, engineer of electric traction.

Wadi Bunder Viaduct, Bombay, With Electric Train

Soo Line Instal's New Test Rack for Regulators

Shop inspections and tests of car lighting regulators are facilitated by the use of a novel test rack built recently at the Shoreham shops of the Minneapolis, St. Paul & Sault Ste. Marie in Minneapolis, Minn. To save floor space the motor-generator unit is arranged vertically with a canvas-rubber belt drive. The rack for mounting the regulators and lamps is located adjacent to the power unit, both frames being constructed from scrap angles and pipes.



The Motor-Generator and Regulator Rack Occupy Very Little Floor Space

An old 4 kw. Safety generator is operated as a 110-volt d.c. motor, using a battery charging rheostat in series with the armature and an old field rheostat from a Kennedy regulator in series with the field to control the speed. Above this machine and suspended from the top of the frame is an old 4 kw. Type-D, 32-volt Consolidated generator, with a Goodrich belt drive between the two machines. The generator is inverted and pivoted on its hanger so the weight of the generator provides the necessary belt tension. The frame is rigidly built from 2½-in. angles, part of the structure being welded together. Supported on a bracket at the right side of the motor-generator frame is the armature rheostat which permits operating the 32-volt Safety generator as a 110-volt motor.

A shop test of a rebuilt generator can be made easily by mounting it in place of the unit regularly used for purposes of testing regulators.

The adjoining rack is constructed of 1-in. pipe and 1½-in. angles with a 6-in. channel iron base. A small switchboard includes the field rheostat for controlling the generator speed and two ammeters, one having a 0-80 scale, the other a 0-120 scale for measuring the generator output and lamp regulator input. In addition to the two ammeters on the board, there is a small portable ammeter with a 50-0-150 scale that can be cut in anywhere. Similarly there is a voltmeter with 0-50 scale on a pivoted support at the top of the test frame and provided with flexible leads which enable the easy determination of voltage drop anywhere on a regulator. Below the switchboard is a three-panel lamp bank with a full load rating of 75 amp. These lamps can be switched on in groups by means of snap switches on the front. The same lamp bank is used for battery discharge tests, using one of the ampere-hour meters on the main charging board which is not shown here.

With this flexible arrangement of equipment it is a comparatively easy task to check the pick-up value of an automatic switch and the functioning of the shunt and series coils, with their dash pots and connections to the carbon pile field resistance. If the dash pots act too sluggishly or stick under changes in generator speed the trouble will be noticed. The arrangement is such that any conditions of car speed and lamp load can be simulated with this test rack. This allows the shop foreman to satisfy himself that any regulator which has been repaired will operate satisfactorily when installed on a car.

A Simply Constructed Paint Sprayer

By Charles A. Graf, Electrician,
P. R. R., Baltimore, Md.

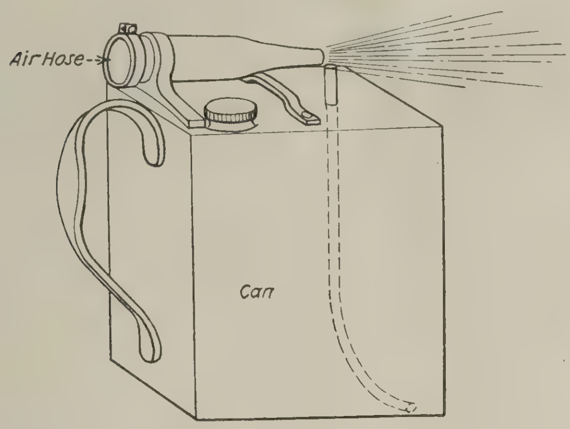
The paint sprayer shown in the illustration has been successfully used in railroad yards and will undoubtedly be of interest to readers of the *Railway Electrical Engineer* who may have occasion to use a similar device.

It is made of a ½ or 1 gallon oil can with a ¼ in. pipe extending all the way to the bottom of the can. This pipe is soldered fast to the top of the can. As may be seen from the sketch, another piece of pipe, one end of which is tapered, is also soldered to the can by means of a suitable metal strap. The tapered end of this pipe is placed so that when an air hose is attached to the large end, a draft of air will be blown across the top of the ¼ in. pipe.

A small vent hole is then made in the top of the can and a handle is attached to the back for convenience in handling. The can is then ready to be filled with paint. As practically all railroad yards have compressed air it is

convenient to attach a hose to the large end of the horizontal pipe by means of a clamp.

There are many sets of alkaline batteries on which the paint is coming off and some of these cannot be cut out for repairs. By blowing these with steam and drying with air, it is possible to paint them all around with this



Easily Acquired Materials Will Construct This Useful Paint Sprayer

sprayer—something which would be impossible to do with a brush without taking them apart.

It has been found that this device works out very well as it is possible to paint the cans all around while in the crates with a result which is the same as dipping, but with much less work and no waste of paint.

"Go West—Young Man"

In *"Forty-nine"* an uncle of mine
Trekked west across the plains.
When oxen trod the virgin sod
And pulled their *wagon trains.*

The alkali dried throat and eye;
They talked with signs and grunts;
While their *cuisines* were pork and beans
For months and months and months.

In each ravine hid Redskin mean,
Who'd learned by other jobs,
Of how to stalk with tomahawk,
And scalp Caucasian knobs.

With faces grim they sang a hymn,
When a comrade bit the dust;
For skulls and heels and busted wheels
Were left to rot and rust.

At last they lit and shook the grit
From the brims of faded hats;
Their boots were thin and the socks within
Resembled knitted spats.

No welcome hand or jazzy band,
Appeared upon the green;
No movie stunt was out in front
To "Shoot" them for the screen.

By sweat and toil they made the soil
Its fruitfulness unfold,
While streams and sand were dammed and panned,
In eager search for gold.

They built a *West,* which men love best,
Out near the Golden Gate,
Where *"Sons"* reside and point with pride,
For none can imitate.

I've often felt that if I dwelt
Within this sunny land,
That I could steal the things *they* feel,
And fully understand.

Today we ride without a guide
Along a graded trail,
Where oxen tracks are made by jacks,
When surfacing the rail.

The smoky spires from *"signal"* fires
Are banished from the plains,
For new aspects today protect
The swiftly moving trains.

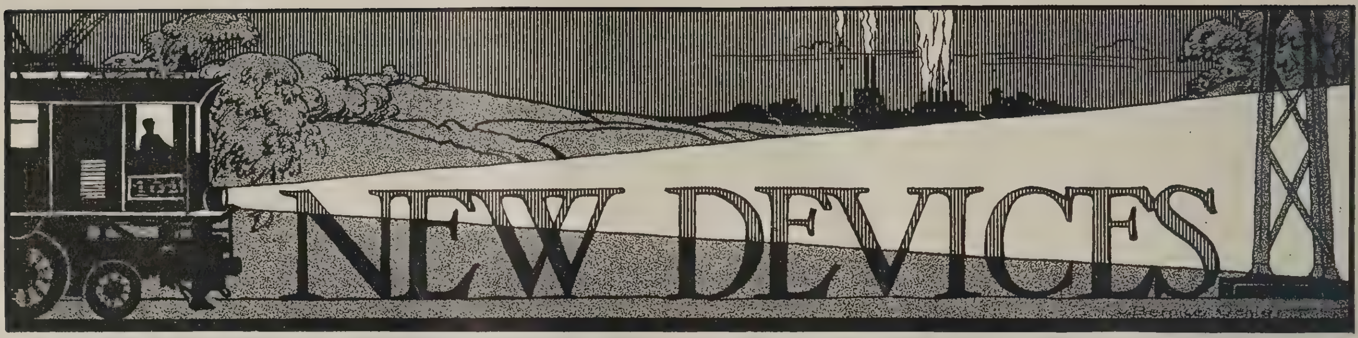
The Redskins mean, who used to lean
Upon a shaggy spear,
Are harmless now, somewhere, somehow,
Beyond this mundane sphere.

So while we sleep, no dangers creep—
From these we find surcease;
We park our shoes and sweetly snooze,
In earthful blissful peace.

The grub we eat would now entreat
The most dyspeptic soul;
There's not a bean in our *cuisine*
That's wrinkled, dried or old.

This trip's been planned, all worry canned,
And the "Covered Wagon" greased;
So pack your grip, load up your hip,
Let your *"yearning"* be appeased.

It's worth your while to ride these miles,
And meet with engineers,
But don't neglect to pay respect
To the Western Pioneers.



Bus and Train Lighting Batteries

In order to meet the demand for a storage battery which is particularly adapted to the requirements of bus and rail motor car service, the Willard Storage Battery Company, Cleveland, Ohio, has developed three types of bus batteries and a special light-weight train lighting battery especially adapted to rail car service.

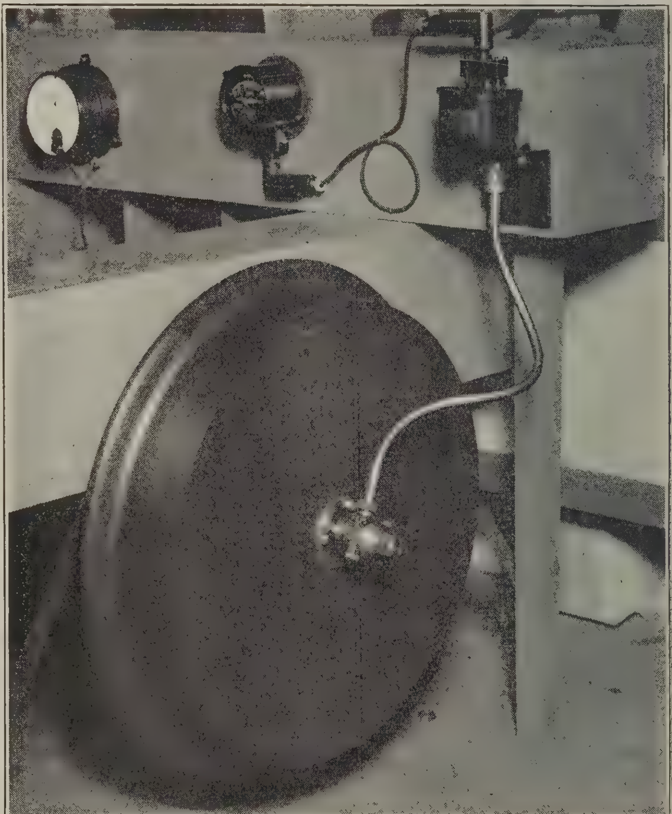
The train lighting battery shown in the illustration is constructed with hard rubber jars and covers, semi-flexible top connectors with perforated rubber separators, and wing nut terminals, the connections being on the front of the case. The battery is built with a 2¾-in. sediment space and a space of 2 in. allowed for the electrolyte over the tops of the plates. The outstanding feature of this particular type of battery is its light weight, which is said to be from 30 to 40 per cent of the weight of commonly used lead train lighting batteries. This battery uses a pasted type of plates with hard rubber perforated retaining sheets. It is possible to assemble the battery in two, three or four-cell trays in order to suit the space in different battery compartments.

Willard Light-Weight Rail Motor Car Lighting Battery

The latest type of bus battery developed by this company is known as the Type PRT. This is constructed with extra heavy plates, eight ribbed threaded rubber insulators and unusually high sediment space.

Magneto Drive for Locomotive Tachometer

A new form of magneto drive has been developed recently by the Electric Tachometer Company, Philadelphia, Pa., in conjunction with the Westinghouse Electric & Manufacturing Company for the application of electric speed indicators to locomotives, independent of train control or other apparatus. This new drive permits the installation of an electric tachometer outfit in a few minutes' time, and eliminates the use of special gears, pulleys or belts.



Simplicity and Ease of Installation are Claimed for This Magneto Drive

As the function of a tachometer in railway service is to indicate train speed to the engineman, the indicator must be accurate and easily read at a glance. The tachometer must be so constructed and protected that it is not affected by severe vibrations, changes in temperature, dirt, water, ice or steam. From the maintenance point of view, a tachometer must be interchangeable, and easy to install on new or old equipment. It must be of rugged construction to stand the knocks of service.

and must require a minimum amount of repair. Adjustments should be accessible for easy manipulation, but the tachometer must hold its calibration permanently, after adjustments have been made.

The electric tachometer, in its simplest form, consists of a magneto-generator driven from one of the locomotive wheels and an indicator located in the cab. The magneto and indicator are connected electrically, and are calibrated together to insure the highest degree of accuracy. Every speed of the magneto corresponds to a definite number of miles per hour on the dial in the cab. The magneto is a direct current generator of the permanent magnet type. The frame, of heavy construction, is water and steam proof. The armature runs in ball bearings which are accessible for oiling and inspection. Perfect contact at the commutator is claimed by the use of 14 karat gold for commutator bars.

The indicating instrument has an open scale which is easy to read and non-shattering glass is used over the dial. The cast bronze case is dirt and steam proof. The indicator element is a direct current voltmeter of the D'Arsonval type, constructed to withstand vibration. It is possible to connect two or more indicators to the same magneto. This is especially desirable in the case of electric locomotives which may be operated from either end.

When the diameter of the locomotive wheel changes, due to wear or replacement, it sometimes becomes necessary to make corresponding changes in the calibration of tachometers. The electric tachometer circuit contains a small rheostat located in the base of the indicator, access to which is obtained by removing a small cap screw. Adjustments can be made directly at the indicator in full view of the dial.

The outstanding feature of the new design is the method of driving the magneto from the locomotive wheel. Formerly it has been necessary to use special gears or a belt for this purpose. The new drive, it is said, eliminates the use of special attachments and also eliminates the possibility of lost motion in a slipping belt. This equipment can be attached to any locomotive easily by the use of ordinary hand tools.

The magneto is mounted (with shaft vertical) on the framework above or adjacent to one of the leading wheels of the locomotive. A small gear box is attached to the end of the locomotive axle, outside of the wheel. Only three small tapped holes in the axle are necessary for mounting. A short length of flexible shaft connects the gear box to the magneto. The gear box contains a pair of bevel gears, one being rigidly attached to the locomotive axle, and the other in a housing which is free to revolve around the first bevel gear as a center. The flexible shaft is attached to the second bevel gear and prevents actual rotation of the housing, although a small amount of motion is permissible. In action, the housing remains stationary and the gears revolve, transmitting motion through an angle of 90 deg. to the flexible shaft and magneto.

This construction it is said reduces the transmission problem to its simplest form and takes care of all movements of the locomotive wheels with respect to the locomotive frame. It allows the magneto to be mounted rigidly, as its heavy construction requires, and at the same time provides a positive drive which is independent of various wheel positions.

New Line of Sol Lux Junior Hangers

The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has recently developed a new line of Sol-Lux hangers, namely, the Sol-Lux Junior hanger for use with Sol-Lux globes. These hangers

Sol-Lux Junior Hanger—Canopy and Upper Part of Chain Not Shown

consist of three types, the medium suspension hanger, the Mogul suspension hanger, and the medium ceiling hanger. They have all the advantages of the Sol-Lux hanger, and are regularly furnished in dull bronze finish.

Melting Pot

An addition to the Trent line of rapid heating melting pots is now being manufactured by Harold E. Trent, Philadelphia, Pa. This pot is suitable for melting babbitt, solder, lead and tin, and has a capacity of 10 lb. It is adapted for 110 and 220 volts a.c. and can be connected to a lamp socket. It will be noticed that there is a new

Full, Medium and Low Heating Rates Are Obtained by Connecting the Attachment Plug to Different Contact Points

design of protected plug contacts at the base of the pot whereby a standard plug can be used to obtain the 3 heat combination.

All pots are fitted with spouts and two handles to facilitate pouring metal if so desired. The crucible is insulated, affording high efficiency.

GENERAL NEWS

The Bridgeport Brass Company has removed its New York City office from the Pershing Square building to the Farmers' Loan & Trust Company building, 475 Fifth avenue.

American Brown Boveri Electric Corporation announces the opening of a district sales office in Philadelphia at 922 Witherspoon building. Louis T. Peck will be in charge.

The Kuhlman Electric Company, Bay City, Mich., has appointed the Continental Sales & Engineering Company as its district representative at 839 Oliver building, Pittsburgh, Pa.

On Saturday, July 24, the New York office of the Bridgeport Brass Company moved from the Pershing Square building to the Farmers' Loan & Trust Company building, Suite 407, 475 Fifth avenue, at Forty-first street.

The Graybar Electric Company, New York, has opened a new branch office and warehouse at Commerce and Buncombe streets, Asheville, N. C. H. H. Hix, formerly of the Atlanta, Ga., branch of the company, is in charge of the new branch.

The Interstate Commerce Commission has modified its automatic train control order as it applies to the Chicago, Indianapolis & Louisville to provide for the installation to be made on that portion of the line between Monon, Ind., and Indianapolis.

Wage increases of approximately one and one-half cents an hour have been granted by the Chicago & Alton to certain of its shopmen, agents and telegraph operators to bring their rates up to a level with those of employees of similar classifications on other roads in the middle west.

The Pennsylvania will discontinue on September 15, ferry service between Cooper's Point, Camden, N. J., and the foot of Vine street, Philadelphia, Pa. This service has been operated by a subsidiary corporation, the Cooper's Point & Philadelphia Ferry Company. Abandonment of the service has been forced by reason of the fact that during only two out of the last ten years have the revenues been sufficient to meet expenses. Since the opening of the new Delaware river bridge on July 1, which is constructed practically over the route of the Cooper's Point & Philadelphia Ferry Company's line, the traffic has diminished to such an extent that the company cannot earn operating expenses.

The Interstate Commerce Commission has suspended the effective date of its first train control order as to Kansas City Southern until further order and that of second order as to Chicago & Alton, which was also granted an extension to January 1 under the first order.

A "college of cookery" is to be established by the Pennsylvania at Columbus, Ohio, for the purpose of training stewards, cooks and waiters for the road's dining cars. It is proposed also to establish similar schools at New York and Chicago. Not only will new men be trained, but employees now in service will occasionally be given short courses, to refresh their training and thus maintain uniformly high standards.

Baltimore & Ohio to Operate Buses in New York and Newark

The Baltimore & Ohio, which had previously been reported as considering the operation of buses in New York City to connect with the Jersey City terminal of the Central of New Jersey, which will be its Metropolitan terminal from September 1 when its contract for the use of Pennsylvania station, New York, expires, has now definitely announced its plans. Buses will be operated from a location on Forty-second street near Grand Central terminal and from other points in New York to the Jersey City terminal and likewise bus service will be provided between Newark, N. J., and the Jersey Central station at Elizabeth. The Baltimore & Ohio, in using the Pennsylvania's terminal facilities, has been serving Newark and the provision of bus service to Elizabeth will enable it to continue doing so.

The initial bus terminal of the service will be located in the Pershing Square building, Forty-second street and Park avenue, New York. There will be another at the Waldorf-Astoria hotel, Fifth avenue and Thirty-third street. In addition, the buses will stop at other convenient points in the city for the purpose of taking on or discharging passengers. The buses will use two routes

to New York from the Pershing Square terminal—one directly downtown via the Liberty street ferry and another via Thirty-third and Twenty-third streets to the Twenty-third street ferry.

There will be three Newark terminals for the Newark-Elizabeth buses, viz., the Jersey Central station, the Public Service Railway station and the Robert Treat hotel. No extra charge will be made for the bus service. The equipment to be used will be of parlor car type with individual seats for 23 passengers, with a compartment for luggage in the rear. Each bus will be manned by a uniformed attendant in addition to the chauffeur. The New York buses will be operated for the railroad by the Fifth Avenue Coach Company and in Newark by the Public Service Transportation Company.

Continuous Train Control Demonstration on the Michigan Central

On July 13, a demonstration of the continuous type of automatic train control (Clark patents) as manufactured by the Continuous Train Control Corporation, New York, was made on the Michigan Central near Rives Junction, Mich. This test, on a 4,000-ft. track section, with one locomotive, is said to have demonstrated the practicability of the principle of the system, which includes a so-called radio feature. An oscillator delivers a high frequency energy to the rails when the signal is at clear and a different frequency when the signal is at caution; while no energy is delivered when the signal is at stop. The current is picked up by receiver coils on the engine, in a manner somewhat similar to other continuous systems.

Traffic Through Panama Canal

The tonnage passed through the Panama Canal in the fiscal year 1926 amounted to 24,774,591 tons, according to the Canal Record, as compared with 22,855,151 in the preceding year and 26,148,878 in 1924, the record year. Excluding tanker tonnage, however, the net tonnage showed an increase of 12 per cent over 1925 and of 16 per cent over 1924. Tanker tonnage amounted to approximately 25 per cent of total net tonnage in 1926 as compared with 39 per cent in 1924 and the gain in commercial traffic excluding the oil was approximately 2,500,000 tons as compared with 1924. In 1926 5,197 ships passed through the canal, as compared with 4,673 in 1924. During the first six months of this year the cargo tonnage was greater than in any previous six months of the canal's history either as to total tonnage or traffic exclusive of oil tankers.

Chicago Electrification Plans

The special committee of the Chicago City Council, investigating the possibility of electrification of railway terminals at a hearing on August 10, listened to George A. Harwood, vice-president of the New York Central. Mr. Harwood cited figures showing the increase of capacity of railways by electrification and also the increase in property values as evidenced at the Grand Central Terminal, New York City. As yet, however, the rents derived by the New York Central from the development of its air rights in New York have not been sufficient to pay the interest on the whole investment. Mr. Harwood would not expect the development of a high class apartment district in Chicago, as there has been no tendency on the part of the people to develop the territory south of Van Buren street. Any electrification plan in Chicago should provide for the interchange of power among the railways, and there should be no duplication of electric installation. Such an elaborate and comprehensive enterprise necessarily makes slow progress; the work in New York City was started in 1903 and will not be entirely completed even in 1928.

Southern Railway in England to Extend Electrification

Following the completion of the Southern's recent suburban electrification program, which, in the main, comprised the old Southeastern & Chatham lines from Victoria, Charing Cross and Cannon street stations, the railroad has announced a further large extension of electrification in the South London area, work to be started at once. The lines to be electrified include the whole of the old London, Brighton & South Coast suburban area, and a small portion of the Southeastern. Plans call for the equipping of 127 single track miles of existing "overhead" system with d. c. third rail, as used on the other electrified lines of the Southern, together with the laying of 105 single track miles at present operated by steam; a total of 232 track miles exclusive of sidings. The work will cost £3,750,000.

Serious Delays in New York City by Flood

An unprecedented rain storm in New York city on Thursday afternoon, August 12, when 3¼ in. of rain fell within 1 hr. 10 min., flooded the tracks of the subways in several places and flooded the four tunnels of the Pennsylvania beneath the East River to such an extent that traffic was not fully resumed for about 24 hours.

The passenger trains of the Pennsylvania between New York and western points are made up at Sunnyside yard, Long Island, and difficulties in moving these trains from the yard to the station imposed delays throughout the evening from about 5 p. m. until past midnight. One through train was delayed four hours in starting. Trains from the west were sent to the old terminus of the Pennsylvania at Jersey City and the congestion at that terminus also caused much delay.

Trains of the Long Island were disarranged by the flood more than those of the Pennsylvania because of having fewer motors which could defy the water, and only one train of the Long Island was run out of the Pennsylvania station, Manhattan, on Friday, until late in the afternoon. Suburban trains, with their thousands of passengers for Manhattan in the morning and equally large numbers from Manhattan in the afternoon, made their termini at points in Brooklyn where passengers could be transferred to or from the lines of the Brooklyn-Manhattan Transit Company and the Interborough Rapid Transit Company. The B. M. T. suffered the least delay because of the flood. The B. M. T. and the I. R. T., though already crowded with their normal traffic, carried most of the Long Island passengers throughout Friday.

It was estimated that the water in the four Pennsyl-

vania tunnels under the East River amounted to 1,500,000 gallons, and pumps were borrowed from the Interborough and the B. M. T. to aid in clearing the tracks. Tunnel No. 4 was cleared at 6 a. m. on Friday and tunnel No. 3 at 10:35 a. m., the pumps taking water out at the rate of 38,000 gallons a minute. Tunnel No. 2 was cleared at 3 p. m. and tunnel No. 1 an hour later.

Traffic was impeded on the Long Island also by washouts at Elmhurst and at two or three other places.

Trade Publications

Pyle National Locomotive Train Lighting System is the title of a 12-page illustrated bulletin recently issued by the Pyle National Company, Chicago, describing the system used by the company for the electric lighting of steam railway cars from a single turbo-generator power plant placed on the locomotive.

Crouse Hinds Company, Syracuse, N. Y., has recently issued bulletins No. 2085 and 2086. The former describes a Condulet for grounding service wires for conduit systems known as type GC Condulet, while the latter bulletin describes "Arktite" plugs and receptacles, interlocking switches and plugs for safety hand lamps.

Electric Controller & Manufacturing Company, Cleveland, Ohio, has just issued its first leaflet on the use and methods of installing EC & M separator magnets. The leaflet shows a number of photographs of this magnet in service, illustrating how they are used in removing undesirable pieces of iron from other substances.

"Power Factor and Means for Its Improvement" is a 33-page illustrated publication recently issued by the General Electric Co., Schenectady, N. Y. This booklet presents in a simple and systematic manner information on means for power factor improvement in industrial plants. It is a practical treatise on power factor with the mathematics reduced to simple arithmetic.

Automatic Voltage Regulators is the title of the General Electric Company illustrated bulletin No. GEA-123. The bulletin contains 60 pages which are divided in two sections. The first section treats of automatic voltage regulators and the second of induction voltage regulators. The text of the combined sections indicates a regulator for practically every voltage requirement.

The Westinghouse Electric and Manufacturing Company has just issued a 112-page publication describing switching equipment for alternating current power stations. This publication, 1541-C, deals with the fundamentals of laying out a switchboard, and describes the various types of switching equipment. It is profusely illustrated with diagrams and photographs.

Six little folders were recently issued by the Okonite Company, Passaic, N. J. The folders are attractively printed in colors. Three of them are devoted to the description of three grades of friction tape manufactured by the company, one to Okonite tape, one to Okonite cement and the final one to Okocord portable cords which are made up in two, three and four conductors and are designed for rough use.

National Lamp Works, Nela Park, Cleveland, Ohio, has recently issued three small illustrated booklets of 16 pages each. The respective titles are "New and Better Lamps," "Printing Plant Lighting," and "Safe Lighting for Dusty Industries." The first is devoted to the details of the inside frosted lamp which has recently been introduced on the market. The second and third booklet deals with the types of lamps and reflectors best suited for the industry mentioned.

The Safety Car Heating & Lighting Company has recently issued two illustrated booklets. The larger of these contains 102 pages and bears the title of "Operation and Care of Under-Frame Car Lighting Equipment." It is primarily a reference book for the man who operates underframe equipment and it gives briefly and concisely the essential points regarding the installation and operation of generators and regulators which form a complete equipment. The second booklet contains 16 pages and carries the title of "Carbon Pile Regulators." It is illustrated with photographs of various types of regulators and circuit diagrams.

An illustrated circular, describing in detail the operations of starting, stopping and protecting generating and converting apparatus in railway sub-stations through full automatic control equipment has just been issued and is being distributed by the Westinghouse Electric and Manufacturing Company. The booklet describes in detail the various operations of the individual units of the control system entering into the conversion of a sub-station to complete automatic control. A discussion is taken up of the protective devices designed to render effective protection from trouble originating either inside or outside the sub-station, a factor of vital importance in full automatic control.

The Pyle-National Company, Chicago, Ill. has just completed the third edition of its No. 101 general catalogue of railway electrical equipment.

This latest edition describes a number of recent developments in locomotive headlight case construction, as well as giving data on the company's established line of turbo-generators and yard floodlights. A representative selection of the Oliver wiring appliances for locomotive, car and shop wiring is included, although the full line of Oliver material is presented in a separate catalogue.

New and complete information on locomotive headlight mountings and recommended wiring for locomtive lighting, etc., is presented, together with tables, diagrams, and material lists.

Around the World with Westinghouse is the title of a 20-page publication recently released by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., containing reproductions of a series of advertisements which appeared in the technical press, describing Westinghouse railroad electrification achievements in the various countries of the world. Each advertisement was devoted exclusively to one country, emphasizing the primary object for electrifying. Illustrations of the type of electric motive power used together with characteristic views of the subject country typify each advertisement. A tabulation of Westinghouse equipped electric motive power units in service throughout the world, giving such data as voltage of system, weight, ratings, year in service, and similar table of multiple unit cars are included in the publication.

Railway Electrical Engineer

Volume 17 OCTOBER, 1926 No. 10

Seventeenth Annual Convention

The seventeenth annual convention of the Association of Railway Electrical Engineers will begin on October 26, at the Hotel Sherman in Chicago. There is much to indicate that this year's convention will go down in history as one of the most successful conventions which the association has ever held. Certainly, there is no lack of important subjects to come up for discussion for there has never been a period in the history of railroad operation when the electrical engineers have been called upon to shoulder so many varied applications of electrical energy to the needs of steam roads. Each year seems to bring greater demands upon those who are responsible for electric equipment and there certainly is no better clearing house for ideas and practices than at the convention of the Association of Railway Electrical Engineers.

The reports of the various committees that will be presented at the convention are published in this issue of the *Railway Electrical Engineer*. They are both numerous and extensive and one in particular, namely, the report of the committee on safe installation and maintenance of electrical equipment, is of unusual length. The information presented in this particular report will be of inestimable value to many of the members, but one cannot read it without wondering just how far it will be possible to extend a report of this nature. The report itself touches upon vital problems in the application of electrical energy to railway requirements, but the title is so comprehensive that it does not seem practicable to cover the subject in its entirety. The ramifications of electrical equipment are so extensive and so varied that whole libraries can be and have been written upon the subject. If this committee is continued, as it probably will be, it will be interesting to observe just where the line is drawn between what to include and what to leave out.

A second report of considerable length is that of the committee on illumination. This year the subject of yard lighting has been touched upon but the committee finds that it is difficult to fix standard recommendations for this work because various installations differ so widely. There is, however, much in the report that is well worthy of consideration.

These two reports are the longest to be offered and as both of them relate to subjects on which the interest is keen, lively discussions should follow their presentation.

There are nine other reports to be presented, seven of which are published in this issue of the *Railway Electrical Engineer*. Most of these are comparatively brief but they all touch upon live issues, covering such subjects as application of radio to train service, train lighting, welding and heating, self-propelled vehicles, locomotive lighting and train control. Much interest will be taken in all of these subjects, but perhaps more particularly in the reports dealing with locomotive train lighting and train control.

The railway electrical engineer today is a busy man and the scope of his work is increasing with each succeeding year. Few, if any, electrical men can afford to remain away from the convention, for in no other way can they obtain the same advantage of interchange of thought or gain so desirable a benefit in so short a time.

The exhibits of the Railway Electrical Supply Manufacturers' Association this year will occupy larger space than last year and a number of products will be shown for the first time. Improvements in the field of electrical appliances are being made so rapidly that unless one keeps in constant touch with the situation, he is more than likely to harbor too many ideas that are obsolete. It will pay you to attend the convention if you can possibly make arrangements to do so.

It Is a Two-Kink Competition

Have you sent in descriptions of TWO kinks for the competition which was announced in the September issue of the *Railway Electrical Engineer?* A number of those who have already entered contributions, have sent only one; as the prizes are to be given for the best collections of two kinks, we wish to call this to the attention of both those who have sent only one kink and also to those who have not yet entered the competition.

If you read the notice in the September issue, you know that we are offering three cash prizes for the best electrical kinks, methods or devices which are time, trouble or labor savers. The prizes will be awarded as follows: For the best two practical kinks, methods or devices, $50; for the second best set of two, $35; for the third best set of two, $20. Regular space rates will be paid for all contributions which are suitable for publication, but which do not win prizes.

You do not have to be an experienced writer to take part in this competition. The thing that will count will be the extent to which the method or device is valuable in saving labor or time. The *idea* is the thing, not the manner in which it is presented.

A simple method of writing such articles is outlined on the following page. Descriptions are usually best when they do not exceed 500 words for each kink. Pho-

tographs, drawings or free-hand sketches make the description easier to understand.

Articles will be received by the Editor, *Railway Electrical Engineer,* 30 Church Street, New York, N. Y., up to, but not later than, November 20, 1926, and the announcements of prize winners will be made as soon thereafter as possible.

The contributions already received show that there are men with brains and originality in the electrical departments. That is a fact which ought to be advertised. Don't you think you should do your part in calling attention to your department? Send in your contribution so that we can send you a contributor's check or perhaps a prize.

How to Write for the Interchange Department

On the preceding page appears a second announcement of the prize competition now open for contributions to the Interchange Department of the *Railway Electrical Engineer.* It is a simple matter to take part in this contest and when you do so, you perform a service both to yourself and to other electrical men. Others can undoubtedly use your ideas to advantage and when you publish a description of a kink you get the best kind of practice in the art of bringing your own ideas and your own personality to the attention of those who can be of most assistance to you. In case you feel hesitant about how to describe a kink the following form is suggested:

Select the device or method that you want to describe and first, give it a name; second, tell what it is used for, or mention reasons why it is useful; third, describe in detail how it is made or what it consists of; fourth, tell how it is used.

You do not need to use a typewriter. Descriptions in handwriting are entirely acceptable. Photographs, blue prints, tracings or free-hand sketches can be used as illustrations.

Train Control Organization Needed

With 8,941 miles of track and 3,910 locomotives equipped with train control apparatus built by at least seven different manufacturers, and including not less than 10 different systems, the need for specific information concerning the maintenance of this equipment is most urgent. Printed instructions in pamphlet form prepared by various manufacturers of train control equipment undoubtedly are a help, but they cannot meet all the requirements of the railroads. There is at the moment a dearth of information concerning the maintenance of train control equipment. Some roads have been able to work out a schedule that seems to suit their needs fairly well, but by far the majority appear to be floundering about with their newly acquired equipment without having much of an idea as to how they should organize their forces and facilities to take care of this recent acquisition; particularly that part of the equipment to which the mechanical department has fallen heir.

The subject is one that is demanding attention and it is time that more concerted action be taken with regard to the maintenance of this sensitive and complicated apparatus.

First of all must be established an organization that will be responsible for this equipment. The formation of this organization is naturally somewhat involved, since those who comprise it must not only have a knowledge of the equipment that is on the locomotive, but also of that which is located along the right-of-way.

Those working upon train control equipment will necessarily have to be high grade men, capable of understanding and appreciating all of the various phenomena which occur in not only normal but abnormal operation of equipment.

Knowledge and Power

Recent surveys of American business and industry made by the National Industrial Conference Board, by the Foreign Trade Council and by Secretary Hoover of the Department of Commerce have revealed the impressive fact that in the ten years following the outbreak of the war, from 1914 to 1924, while the number of wage earners in American industry increased approximately 27 per cent, their output in terms of quantity, increased by at least 60 per cent. Production per wage earner advanced by some 25 per cent.

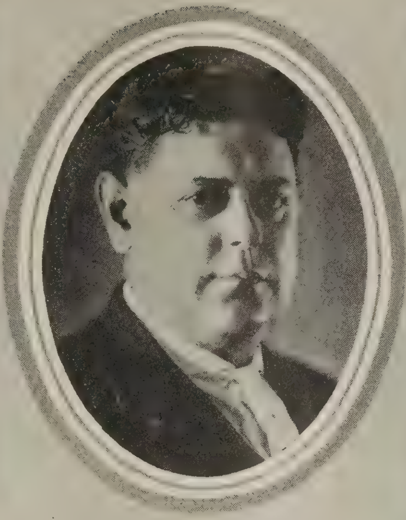
This increase has been effected primarily by the greater and more intelligent use of electric power and it is of just as much effect in the railroad industry as it is in manufacturing. According to the old proverb "Knowledge is Power," the American Library Association recently issued a bulletin showing how the average worker can improve his position by taking advantage of the resources at his command. The bulletin lists night schools, vocational schools and correspondence schools as important assets to the worker and points out that in the public libraries can be found books on economics, elementary engineering, science, and the application of science to commerce and industry. Periodicals such as the *Railway Electrical Engineer* fulfill a part of the workers' needs. They serve not so much to supply fundamental knowledge as to supply the worker with information concerning the day-to-day progress that is being made in his particular field. You can't afford to be without a knowledge of both. That sounds like preaching, and preaching is often distasteful, but a little gospel now and then is good for every one of us if we will only take it to ourselves personally and not look upon it as something that is good enough but meant for the other fellow.

New Books

Elements of Alternating Currents and Alternating Current Apparatus. J. L. Beaver. 370 pp., 1926, N. Y., Longmans, Green & Co.

"Written for beginners in alternating currents, either electrical or non-electrical students." The first eight chapters discuss vectors, alternating-current conceptions, average and effective values, rate of change, series circuits, parallel circuits, complex quantities, and single-phase and polyphase relations. The remaining five chapters are devoted to studies of the more usual types of alternating-current apparatus. Alternating-current instruments and measurements, and the calculation of medium-sized transmission lines are briefly treated in two appendices. Lists of questions and of problems are appended to each chapter.

C. R. SUGG
Atlantic Coast Line
First Vice President



E. WANAMAKER
Chicago, Rock Island and Pacific
President

J. A. ANDREUCETTI
Chicago and Northwestern
Secretary and Treasurer

Association of Railway Electrical Engineers Seventeenth Annual Convention

October 26th to 29th, Chicago

Convention Program

Meetings in the Grand Ball Room, Mezzanine Floor, Hotel Sherman, Exhibits Will Be Located in Exhibit Hall, Mezzanine Floor

TUESDAY, OCTOBER 26TH

Session 10:00 A. M. to 12:00 Noon

Address of President.
Report of Secretary-Treasurer.
Report of Auditing Committee.
Unfinished Business.
New Business.
Election of Officers.
Sponsor Committee on Wires and Cables (of "American Engineering Standards Committee").
Committee on Application of Radio to Railway service. (pg. 339).

WEDNESDAY, OCTOBER 27TH

Session 9:30 A. M. to 12:00 Noon

Committee on Train Lighting. (pg. 340).
Committee on Standardization of sizes of threads and bolts and screws.
Committee on Power Plants (Progress Report).
Committee on Electric Welding and Heating. (pg. 344).

THURSDAY, OCTOBER 28TH

Session 9:30 A. M. to 12:00 Noon

Committee on Safe Installation and Maintenance of Equipment. (pg. 310).
Committee on Illumination. (pg. 331).
Committee on Self-Propelled Vehicles (Progress Report). (pg. 348).

FRIDAY, OCTOBER 29TH

Session 9:30 A. M. to 12:00 Noon

Committee on Train Control. (pg. 345).
Committee on Locomotive Electric Lighting. (pg. 348).
Committee on Loose-Leaf Manual. (pg. 344).

REGISTRATION

Please register and secure badges and tickets at the Secretary's desk. Located near entrance of Exhibit Hall on the Mezzanine Floor.

Theater, Dinner and Card Party Tickets should be reserved at time of registering.

Entertainment

Exhibits are located in the Exhibit Hall on the Mezzanine Floor and will be open from Monday evening until Friday afternoon.

Tuesday evening, October 26th.—Hallowe'en Party. Louis XVI Room, first floor, 8:30 P. M. Refreshments will be served. Admission by badges.

Wednesday afternoon, October 27th, 2:00 P. M.—Theatre Party for Ladies only: "My Country" at La Salle Theatre. Secure tickets at Secretary's desk from Tuesday noon up to Wednesday noon. Tickets should be reserved at time of registering.

Wednesday evening, October 27th.—Frolic Grand Ball Room, Mezzanine Floor, 8:30 P. M. Admission by badges.

Thursday evening, October 28th.—"Seventeenth" Annual Dinner Dance and Entertainment, Grand Ball Room, Mezzanine Floor, 6:30 P. M.

Friday afternoon, October 29th.—Ladies' Card Party, 500 and Bridge. Crystal Room, first floor, 2:30 P. M. Admission by ticket.

Report of Committee on Safe Installation and Maintenance of Electrical Equipment

Committee:—

George T. Johnson, Chairman, assistant electrical engineer, New York, New Haven & Hartford; George Dodds, electrical engineer, Delaware & Hudson Shops; E. R. Hall, road foreman of electricians, Chesapeake & Ohio; Alex. Weir, electrical inspector, New York Central.

To the Members:

This report is intended to lay particular stress on the safety features involved in the installation and maintenance of electrical equipment and apparatus. The rules and practices recommended herein are not intended for the guidance of electrical workers alone, but they apply equally as well to machinists, millwrights, oilers and others who work around machinery operated by motors or other electrical apparatus.

INSTALLATION

General.

First.—All new work should be installed in the safest way possible.

Second.—Existing installations should in all cases be brought up to safety standards as soon as possible.

Third.—All work must be in accordance with the rules and regulations of the "National Electric Code," prepared by the National Board of Fire Underwriters, as issued, revised and in effect from time to time hereafter and such local ordinances as may be in effect where the installation is being made.

Fourth.—All conductors, however well insulated, should be treated as bare, to the end that under no conditions, existing or likely to exist, can a ground or short circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to a minimum.

Fifth.—In all cases where a ground connection is required, it is recommended that these connections be made to a cold water pipe, which is known to form a permanent and positive ground. If a cold water pipe is not available, it is recommended that a ground connection be made by driving not less than a ½-in. iron rod or larger in the ground a sufficient depth to insure a permanent ground and that such grounds be inspected at frequent intervals, and if found defective, renewed. In all cases, approved ground clamps are recommended.

Sixth.—It is recommended that all new inside installations shall be made in approved conduit or approved armored cable, and when extensive repairs are made to old installations of open wiring, conduit shall be substituted.

Seventh.—It is recommended that all high voltage wiring (601-5,000) shall be in approved lead cable or armored cable, run in conduit where used for interior work.

Eighth.—The term commonly referred to as "CONDUIT" in this report, is intended to include all kinds of approved conduit.

Ninth.—Where any installation is not covered by the above, use good judgment to make it safe.

Tenth.—All buildings and compartments for housing electrical equipment should be fire-proof in construction, dry, well ventilated, free from hazardous conditions, with maximum of natural lighting supplemented with artificial and necessary emergency lighting.

Eleventh.—Easily accessible lockers of compartments should be provided for the storage of materials and tools. Floors must have even surface and afford secure footing. Railing and toe boards (or equivalent) must be provided for any platforms having an elevation 4 ft. or more above the floor and around all openings over 18 in. deep.

Twelfth.—Head room not less than 6 ft. 5 in. is recommended for all passage ways and stairways. Hand rails must be provided for all stairways and the treads of open type stairways should be provided with toe boards over exposed, live, or moving parts, working spaces or passage ways.

Thirteenth.—Sufficient exits, properly marked, must be provided to afford a means of exit under any possible condition arising from fire or failure of equipment.

Fourteenth.—Buildings or apartments for housing oil-filled apparatus should be isolated as far as possible by suitable fire-proof walls, partitions or other barriers with oil sills or other devices for retaining escaping oil. Walls of buildings adjoining out-door installations of oil-filled apparatus in addition to being of fire-proof construction should have doors and windows arranged to prevent spread of fires due to burning oil.

Equipment and Material.

First.—Use only such equipment and material which is inspected and approved by the Underwriters' Laboratories and which as far as practicable incorporate safety devices which will protect both operator and equipment.

Second.—In consequence of liability involved by accident, primary consideration should be given to the safety features rather than to the first cost.

Generators.

First.—All electric generators and supply equipment shall have the exposed non-current carrying metal parts permanently grounded. This to include frames of generators, switchboards, transformers, lightning arrestors, enclosed switches and operating levers. However, this rule does not necessarily apply to d.c. generators having one pole grounded.

Second.—Flywheels and belts should be guarded. Flywheel pits should be covered or guarded.

Third.—Rotating electrical equipment or prime movers of such design that through failure of any constituent part are apt to attain a dangerous speed must be provided with automatic stop or speed limiting device of such construction that they cannot be made inoperative.

Switchboards—Power panels or sub-stations. (Not distribution panels.)

First.—All systems should be of the dead front type.

Second.—All switches on circuits above 300 volts a. c. should be the oil type, preferably having separate cells for each pole and have proper disrupting capacities in order to insure the performing of its functions with safety and properly protect the apparatus to which they are connected.

Third.—Care should be taken in using only pure mineral oil having the following characteristics for use in oil switches:

Where not subjected to a temperature below zero degree C., 32 deg. F.

Flash point, 185 deg. C.
Burning point, 210 deg. C.
Freezing point, 10 deg. C.
Viscosity at 49 deg. C., 105 sec.

Where oil switches are installed in unattended places or unheated buildings, in outdoor installations or on pole lines, the oil should have the following characteristics:

Flash point, 155 deg. C.
Burning point, 180 deg. C.
Freezing point, 40 deg. C.
Viscosity at 40 deg. C., 80 sec.

The viscosity is to be determined by a Saybold Viscometer.

Fourth.—Differential relay protection should be installed between alternating current generators and switchboard busses.

Fifth.—All alternating circuit feeder circuits should be protected with automatic inverse time limit overload oil switches.

Sixth.—Switchboards should be so installed that there will be ample space between conductors and wall to permit workmen to make repairs with safety, this space to be enclosed behind locked doors.

Seventh.—All existing switchboards should have rubber mats in front and rear of same.

Eighth.—Fuses are not recommended where automatic circuit breakers can be used.

Ninth.—Reactance should be installed in feeders.

Tenth.—Remote (mechanical or electrical) controlled oil switches are recommended for all circuits having potential over 2,500 volts a. c.

Eleventh.—Means must be provided to make equipment and switches inoperative to unqualified and unauthorized persons.

Motors and Control Equipment.

First.—Strict conformance to the National Electric Code is recommended. Also local ordinances, where equipment is installed.

Second.—Each equipment should be provided with separate safety disconnecting knife switch to disconnect both control and motor from line so repairs may be made with safety.

Third.—All power lines supplying current to a motor must be dead on the load side of controller or starter when starting apparatus is in the "off" position.

Fourth.—All controllers with exposed live parts should be enclosed in safety cabinets, with doors so arranged that only authorized persons may have access to same.

Fifth.—Motor-starting rheostats should be enclosed in metal covers, with handles for external operation.

Sixth.—All protective devices used in connection with motor control apparatus should be provided with full magnetic or thermal overload and under-voltage protection with hand reset, except where used on automatic equipment it need not be hand reset.

Seventh.—Where motors are so installed that there is a liability of accident, adequate guards should be placed around same to protect workmen. This to include belts, gears or other transmitting devices.

Eighth.—Hand-operated starters and push-buttons of remote control starters should be within sight of the equipment controlled, unless such equipment is within an enclosure.

Ninth.—Where motors drive line shafts or particularly dangerous machinery, such as planers in wood mills, elevators, etc., it is recommended that emergency stop stations be provided in accessible places so the equipment may be stopped in case of an accident. It is further recommended that there shall only be one starting station.

Tenth.—The frames of all motors and each piece of control equipment must be thoroughly grounded.

Eleventh.—Caution placards admonishing danger should be conspicuously placed at such a location as to warn employees and others of the presence of high voltage and equipment.

Wiring.

First.—Strict conformance to the National Electric Code is recommended.

Second.—It is recommended that all new installations be made in conduit.

Third.—Special attention should be paid to the mechanical execution of the work, careful and neat rewiring, connecting, soldering, taping of conductors, securing and attaching of conductors and fittings are especially conducive to security and efficiency.

Fourth.—In laying out an installation, every reasonable effort should be made to secure distribution centers located in easy accessible places, at which points cut-outs and switches controlling the several branch circuits can be grouped for convenience and safety of operation. The places selected for cut-outs and switches should at all times be kept clean and accessible and the piling of boxes or storing material in front of same is prohibited. The load should be divided as evenly as possible and all unnecessary wiring avoided.

Fifth.—It is recommended that all high voltage wiring (601-5,000) shall be run in approved lead or armored cable, run in approved conduit, where used for interior work.

Sixth.—The installation of high potential circuits is adequately covered by the National Safety Code.

Seventh.—It is recommended that all single phase lighting circuits of over 30 amp. be run as a three-wire circuit, using an unfused, grounded neutral. Branch circuits may be run either as a two or three-wire system.

Eighth.—The use of fuses for the protection of motors is condemned.

Ninth.—(a) Entrance and branch line fuses must be provided as required by the National Electric Code, but where it is practicable to install automatic circuit breakers, they are preferred. The selection of circuit breakers to be governed by local conditions.

(b) In lighting circuits, the use of fuses is satisfactory when installed according to the National Electric Code.

(c) The capacity of the fuse should never exceed the capacity of the wire which they are to protect.

(d) One time or refill fuses. It is recognized that both types of fuses, when properly installed and maintained, perform the functions for which they were intended. It is further recognized that both types have characteristics both favorable and unfavorable and the type of fuse to be used depends largely upon local conditions, as well as the class of supervision and inspection maintained. This committee does not deem it advisable to recommend either type exclusively, as either type will protect operator when properly installed and maintained.

(e) All switches must be so designed that when installed the blades will drop open, and when of the fused type, the fuse must be on the hinged side of switch. In this design of switch the blades and fuses will be dead at all times when the switch is open.

Tenth.—No circuit shall be on more than one switch. It has been found in several cases where a line will have two or three switches feeding it, and an employee will pull one switch and still the line will be hot.

Portable Equipment.

First.—For portable equipment, other than small hand lights, it is recommended that armored cable or additional wire be used for grounding the machine. When armored cable is used, it must be so connected that it will form a grounded connection to the conduit system.

Second.—Safety type receptacles are recommended for connecting all portable power apparatus, such as welding machines, rivet heaters, etc., operating on a voltage of 220 or higher. By "safety" type receptacles is meant one which will embody the following features in combination with a switch or disconnecting device:

(a) The device cannot be connected to the receptacle unless the switch is open.

(b) The connecting plug cannot be withdrawn from the receptacle until the switch is opened.

(c) The switch cannot be closed unless the plug connection is connected with the receptacle.

(d) The plug should be provided with a grounded connection so that the ground conductor from the portable motor or device can be attached in a safe and effective manner.

Third.—The transformer type welding machines should be equipped with an automatic over-voltage release which will limit the voltage across the welding leads to not more than 60 volts, when the arc is broken or circuit is open. The iron core of transformer should be grounded similar to the frame of portable motors.

Fourth.—For portable extension hand lights, it is recommended that composition or other well-insulated sockets of the keyless type be used in connection with wooden handles or other insulating material to which is attached a well-constructed guard.

GROUNDING—GENERAL

Attention is called to the gradual increase in switch capacities, and it is recommended that where grounding wires are to be used in installations of over 600 amperes the sizes called for in the National Electrical Safety Code be discarded and the proper size of wire be worked out allowing a safety factor of 3.

Grounding has been neglected in the past, but it is recognized that it is as necessary to safety of property and life as other rules and regulations, and particular attention must be paid to the engineering and maintenance in order to secure the best results.

Ground connections have in recent years come to play an important part in electrical systems of almost every kind. One of their chief functions is that of protecting persons against electrical dangers. When depended upon for this purpose, they should be carefully made, because if they are poorly made, or inadequate for the purpose for which they are intended, loss of life or serious personal injury may result.

The purpose of a ground connection is to keep some point in an electrical circuit, or some conducting body, at, or as near as practical to, the potential of the ground in order either that safety to life and property may be secured, or that there may be increased convenience and continuity of service in the operation of electrical systems.

Although special emphasis must be given to life hazard, the same careful requirements for a ground connection must be met in order to reduce property hazard, increase convenience of operation and provide continuity of service.

The fire and accident hazard which exists where there is a high resistance or deteriorated ground connection is well known, and is shown by accident records. This hazard might be the result of fuses not blowing when the circuit becomes grounded; the arc may, therefore, hang on and cause fire. Protective devices might not function. Therefore, it is very advisable to maintain a low resistance and reliable ground circuit at all times.

The various types of ground connections in common use may be enumerated as follows: Driven Grounds, Plates, Strips, Patented Devices, and Water Pipes.

Substantial construction is one of the first considerations in

making ground connections of any type and should never be sacrificed to expediency; for, if grounding is poorly done it might in most cases as well not have been done at all; ground wires break, clamps come loose, electrodes corrode away, and even though repairs are constantly attended to, the protection afforded may be inadequate and unreliable. Moreover, the presence of a ground connection of any kind engenders a feeling of security which is false unless the materials and workmanship are of the best. Too much emphasis can hardly be laid upon the necessity for carefulness in this particular feature of electrical practice.

Water piping systems afford by far the best grounding systems obtainable, and should be used for grounding purposes wherever possible. Due to their great extent, water systems have a very low resistance, usually only a fraction of an ohm. Furthermore, they are of a very permanent nature, and connections to them are generally easy to install and inspect.

Water systems have such a comparatively low ground resistance that where they are in proximity to pipe or plate grounds it has been found that a difference of potential will exist between the two during ground fault conditions, which may constitute a hazard to life unless they are connected together. An additional hazard may also exist when ground currents, resulting from a fault foreign to the station, return through a piping system which is isolated from the station ground. For safety considerations, therefore, water pipes when adjacent to equipment to be grounded should always form an integral part of the grounding system. Since there is no danger to water pipes of electrolysis by stray alternating currents, the permission to ground to water systems should not be difficult to obtain, especially in view of the great advantage to the public in the protection of human life and the slight disadvantage, if any, to the water utilities.

In making connections to water piping systems it is, of course, advisable to ascertain if the piping is large enough, and if the material used in the pipe joints has a low enough resistance and sufficient thermal capacity to carry the maximum possible ground fault currents. Care should also be exercised to electrically connect all parts of the piping systems liable to be physically disconnected and to shunt the pipe system where necessary around meters and shut-off cocks, in order to keep the connection with the underground piping system continuous.

Unfortunately, water systems are available only in built-up districts, and, as a rule, can only be taken advantage of at indoor and moderate voltage substations.

At high tension substations in outlying districts it is generally necessary to resort to artificial grounds such as pipe or plate grounds. From the results of the survey it is interesting to note that the tendency is away from the use of plate grounds and toward the greater use of pipe grounds, due principally to the fact that in most cases the same results can be obtained with driven pipes at a much less expense than with plates. See Appendix "A" for characteristics and proper methods of installing ground pipes.

Although a single pipe ground has a higher resistance than a single plate ground, a pipe ground resistance of almost any desired value can be obtained by multiple grounding; that is, by connecting numerous pipes in parallel. In this way a ground of a given resistance can be obtained more economically with pipes than with the use of plates, and in addition the multiple pipe ground will have the advantage of providing a well-distributed ground which, as pointed out previously, is a very important requirement. For average conditions it can be stated that pipe grounds have the advantage over the various forms of buried grounds, in that they

(a) Are more economical

(b) Are more easily installed, since no excavation is required.

(c) Allow for convenient inspection and test, since connections can be made above ground.

(d) Provide a distributed ground over a considerable area when used in multiple.

(e) Are capable of reaching depths of 20 feet or more when necessary to reach permanent moisture level.

There are many patented ground devices on the market, but very few companies reported their use. In general, it appears that the same results can be obtained by the use of pipes and at less cost.

It may be advisable, in some cases, to use other forms of artificial grounds than pipe grounds. For example, where the ground area is very limited it may be impossible to drive a sufficient number of pipes to obtain the required minimum value of ground resistance, in which case ground plates may give better results. For other localities, where the bed rock is near the surface of the ground, it may be out of the question to drive pipes or to dig deep enough to set ground plates, in which case the best procedure is to bury long, narrow strips of metal in trenches dug as deep as the rock layers will allow.

In arid regions and in localities with sandy or rocky formations it is generally very difficult to obtain a good ground with any type of ground electrode. The effect of the type of soil on the value of the resistance of a ground connection is shown very clearly in Table I. In the far west, where grounding difficulties are frequently encountered, satisfactory grounds have been obtained by grounding to the steel casings of deep wells. These casings are generally 6 to 10 inches in diameter and may reach a depth of 50 to 150 feet.

TABLE I

MEASUREMENT OF GROUND RESISTANCE BY THE BUREAU OF STANDARDS

Summary taken from the Electrical Review, June 16, 1918

No. of grounds tested	Soil	Aver. Resis.	Minimum resis.	Maximum resis.
24	Fills and ground containing more or less refuse, such as ashes, cinders and brine waste	14	3.5	41
205	Clay, shale, adobe, gumbo loam and slightly sandy loam with no stones or gravel	24	2.0	98
237	Clay, adobe, gumbo and loam mixed with varying proportions of sand, gravel and stones	93	6.0	800
72	Gravel, sand or stone with little or no clay or loam	554	35.0	2,700

Much benefit can also be obtained by treating the soil surrounding electrodes with chemicals, such as ordinary salt, copper sulphate, etc., because, of the total resistance of a ground connection, the most important part is contributed by the soil, the resistance of the electrode and the contact resistance between electrode and soil under ordinary conditions being negligible.

The electrical conductance of any soil is by means of the electrolytes formed by moisture combining with the soluble acids, alkalies and salts in the soil, and where they are lacking their artificial introduction will show excellent results. It should be kept in mind, however, that artificially treated soils require close attention and inspection, as the chemical must be renewed from time to time. Very few companies report the use of chemicals and their use is recommended only in overcoming unusually adverse grounding conditions.

The resistance of a ground connection can also be reduced by burying the ground electrode in coke, or, in other words, replacing a volume of earth of high resistivity surrounding the electrode with an equal volume of coke of low resistivity. Since the coke constitutes virtually an extension of the electrode, it should have a large area of contact with the soil in proportion to its volume. It is interesting to note that tests conducted by the Bureau of Standards show that whether the coke is wet or dry makes but very little difference, as far as the resistivity of coke is concerned; that is, moisture changes in affecting the resistance of ground connections made with coke act only on that part of the resistance contributed by the soil. As compared with the use of chemicals, coke has the advantage that it does not have to be renewed, but has the disadvantage that it is necessary to excavate to get the coke in place. Furthermore, great care must be exercised to see that the coke is well packed, because, as discovered in tests made by one company, small arcs were drawn when heavy currents passed through the ground which set the coke on fire, melting some soldered joints and burning the connecting leads open.

The greatest disadvantage in the use of either coke or salt is the increased rate of corrosion of the electrode. Where such materials are used it is, therefore, necessary to examine the ground electrodes often and renew them when necessary. Of the chemicals, copper sulphate has the advantage over salt in that no corrosion seemingly attends its use, because when electrolysis takes place between the earth and the electrode there is a tendency for copper to be deposited on the electrode, which will preserve it. Comparative tests on copper plates buried in coke treated with salt and with copper sulphate showed that at the end of three months the copper wires leading to the plates buried in salted coke were completely eaten off and one-third of the area of the plate had wasted away. The plates buried in coke treated with copper sulphate were only slightly pitted, due to the activity of various salts in the soil.

The size of the ground bus required depends, of course, on the length of connections between ground electrodes and on the maximum ground current under short-circuit conditions, and in many cases will require a conductor size larger than No. 0 copper.

If grounding conditions near the various pieces of equipment to be grounded are not favorable, then it may become necessary to run the ground bus some distance to a better grounding point. Under all conditions, however, as good a ground as possible should be made near the equipment so as not to depend entirely on long connections to distant points.

The connection of the bus to the ground electrodes and between the equipment and the ground bus should be as short and direct as possible, very reliable, free from the likelihood of mechanical injury and made in such a manner as to be accessible and easily inspected. The location of the ground connections should also be such that the chance of their being struck by an arc to ground and burned off is reduced to a minimum.

Each piece of equipment should be connected to the ground bus by a direct individual connection, which should be large enough to carry the maximum short circuit currents which may be imposed on the ground connection. In case it becomes necessary to group ground connections on a common lead, then the grouping should be such that high tension safety grounds, low tension safety grounds, power grounds and lightning arrester grounds are segregated and connected to the main ground bus over different routes.

The survey on grounding practice shows that the majority of companies terminate the overhead ground wire on overhead lines one or more spans away from the substation, the object seemingly being to prevent lightning disturbances from entering the substation. In several cases, however, it was stated that the object of isolating the overhead ground wires from the substation grounds was to reduce the complication of numerous wires entering the substation. On a well-grounded overhead ground wire, lightning disturbances are probably dissipated before reaching the station. At any rate, the disturbances entering the station over the ground wire should be no greater than those entering over the power lines which discharge into the lightning arrester grounds, which in turn are generally connected to the station ground. This indicates an inconsistency in practice, and if no ill-effects are experienced from the connection of lightning arrester grounds to main station ground, none should be expected from connecting the overhead ground wires to the same grounds. That this reasoning is substantiated by actual operating experience is borne out by the fact that a number of the largest companies operating extensive overhead transmission systems connect the overhead ground wires to the substation ground and have experienced no ill-effects whatever from the connection. As a matter of fact, many advantages are claimed for operation with overhead ground wires connected to substation grounds since it improves the transmission line as well as the substation grounds, resulting in improved relay action because a positive ground return is provided for short circuit currents, and reduces the hazard to life due to potential gradients in the earth between the transmission line and substation grounds. In this connection it is interesting to note that two large companies are compelled to connect the overhead ground wires to their substation grounds in order to eliminate hazardous potential gradients under abnormal conditions. In each case improvement in relay operations were also reported after the connections were made.

It is evident, therefore, that in order to obtain the full benefit of overhead ground wires they should be connected to the substation grounds. This connection is usually made through the substation steel switching structure, which in turn is connected to the main station ground at numerous points, but in many cases it may be desirable to make a direct copper connection to the station ground.

Eight companies reported that operators had been shocked when in contact with the operating mechanism of disconnecting switches. The mechanisms in all cases were supposedly well grounded, but no additional safety features, such as insulated platforms or rubber gloves, were used. The shock in these cases were evidently due to potential gradients between the ground connection and ground. As previously pointed out, the greatest portion of the resistance of a ground connection is in the soil within a few feet of the ground electrodes; consequently, a person standing or walking near a ground electrode, or, worse yet, standing on the ground and touching a grounded switching structure or operating mechanism would be subjected to dangerous potentials in case of heavy current flow through the ground connection.

This indicates that operating mechanisms of disconnecting switches must not only be well grounded, but also grounded in such a way as to eliminate hazardous potential gradients. This requires a well distributed low resistance ground near the operating mechanism and under the path or walk leading up to the switch, so that the operator can leave the switch in safety in case of trouble.

Furthermore, sole reliance should not be placed on ground connections, because there is a possibility of their breaking or burning off at a critical moment. Consideration should, therefore, be given to the use of insulated platforms, removable impregnated wooden operating handles which can be kept in a dry place, or rubber gloves, by operators when operating disconnecting switches.

To obtain continuous and reliable service from grounding systems requires a systematic routine inspection and the measurement of the electrical resistance of ground electrodes and all connections comprising the system. The importance of adequate ground connections is so great that the practice of making periodic tests is highly commended.

Of those making periodic measurements, the usual practice is to make them at intervals of one year. This can be considered as a satisfactory interval as serious deterioration by corrosion, except where chemicals or coke are used, cannot be expected in a single year. The possibility of mechanical injury, however, exists at all times, and visual inspections should be made at shorter intervals in order that any defects which may exist can be remedied at the earliest practicable moment.

The characteristics of a ground connection which should be known are resistance, capacity to dissipate energy, and possible potential gradient in the vicinity of a ground electrode when heavy currents flow to ground. In general, it can be stated that if a well distributed multiple ground system meets resistance requirements, it is not likely to fall short in regard to the other two. As the test for the second requirement takes considerable time and consumes a large amount of energy, it can be dispensed with except for certain cases where doubt exists as to the ability of a ground connection to dissipate large amounts of energy.

Although the characteristics of the potential gradient in the vicinity of a ground electrode are already well known, a test should prove of great assistance in laying out a grounding system to assure that a sufficient number of ground electrodes are used and that they are properly spaced.

Since the principal test of a ground connection is the resistance measurement, it will be discussed in greater detail. Resistance measurements should be made in all cases when grounds are first installed and at regular intervals thereafter. A record should be kept showing the exact location of the ground electrodes and connections to facilitate the tests. Due to the great effect of moisture and temperature on the resistivity of soil as shown in Appendix "A," the periodic resistance measurements should be made under extreme weather conditions, such as mid-winter or mid-summer.

In a multiple ground system with numerous ground electrodes, tests can be greatly facilitated by installing the electrodes and ground bus in such a way that the system can be sectionalized into small groups and resistance measurements made of the various groups. Unless a reference ground of known resistance is available it should be possible to split the ground system into at least three sections, so that the three-point method of measurement can be applied.

APPENDIX A

Characteristics of Ground Electrodes

A ground may be considered as a metallic conductor in a hemispherical mass of earth, as shown in Fig. 1, the radius of which will depend upon soil conditions. Assume that the outside or boundary of this hemisphere is earth at zero resistance and zero potential. The resistance of the ground connection is the resistance offered to the flow of current from A to B. This resistance consists of four parts, viz.: (1) that of the wire or connection to the ground electrode; (2) the resistance of the electrode; (3) the contact resistance between the electrode and earth, and (4) the resistance of the soil in the immediate vicinity. Unless a long wire is used and unless the electrode is of great length and small cross section, the first two parts of the total resistance will be negligible. Furthermore, the contact resistance between metal and earth, as determined by tests made at the Bureau of Standards, can also be neglected as far as practical purposes are concerned—a fact which has not been generally appreciated. The principal part of the resistance of a ground connection is in the soil surrounding the electrode, and it is for this reason that the resistance of a ground connection varies so greatly for different soils.

Pipe Grounds. The electrical characteristics of ground pipes have been definitely determined for general conditions in extensive tests conducted by the Bureau of Standards and others. Quantitative values on the resistance of pipe grounds may be summarized as follows:

(a) As shown in Fig. 2, the decrease in resistance with increased size of pipe is quite appreciable up to a pipe size of about one inch, beyond which the curve becomes quite flat. From the standpoint of resistance there is, therefore, no economy in using a pipe size larger than one inch. In exceptional cases, where pipes must be driven to a great depth, 1¼-inch or 1½-inch pipe may be preferable in order to withstand the strains incident to driving.

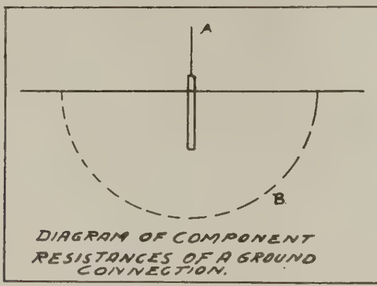


Fig. 1

It has been found that from the standpoint of resistance no difference can be observed between pipe grounds made with ordinary pipe and galvanized pipe, provided the former has a clean surface presenting no grease or paint or other insulating coating. Rust on the surface of a ground pipe is of little or no account in increasing contact resistance, since rust is iron oxide, which is permeable to water and is of no greater resistivity than soils. The relation of pipe diameter to resistance of a driven pipe will also hold true for steel or copper-clad steel ground rods.

(b) As shown in Fig. 3, very little decrease in resistance is obtained by driving pipes to a greater depth than 10 feet, provided that permanent moisture level is reached at this point and that it extends below the frost line. Soil conditions in some localities are such that it is impossible to drive a pipe to a depth of 10 feet, but where at all possible a depth of at least 6 feet should be attained, because for a lesser depth the resistance increases very rapidly.

(c) As shown in Fig. 4, ground pipes should be spaced at least 6 feet apart in order to obtain the minimum resistance for two pipes in parallel. Fig. 5 shows the reduction in resistance affected by a larger number of pipes in parallel.

As previously stated, 90 per cent of the resistance of a pipe ground falls within a radius of 6 to 10 feet around the pipe. By using a spacing of at least 6 feet, each pipe is kept out of the dense current field of the other and a minimum resistance is obtained for the group of pipes as a whole.

(d) Fig. 6 shows very strikingly the effect of moisture content on the resistivity of soils. Above a moisture content of 20 per cent there is very little variation in soil resistivity with variation in per cent moisture in the soil. Below a 20 per cent moisture content the soil resistivity rises very abruptly as the curve shows, being thirty times as great with a 10 per cent as with a 20 per cent moisture content.

Since the normal moisture of soils ranges from 10 per cent in dry seasons to 35 per cent in wet seasons, with an approximate average of perhaps 16 to 18 per cent, it is of great importance that the effect of moisture in soils be fully appreciated.

(e) Fig. 7 shows the variation of soil resistivity with temperature. Above freezing, that is 32 deg. Fahr., it is noted that the effect of temperature is quite negligible. Below 32 deg. Fahr. the soil begins to freeze and introduces a tremendous increase in the resistivity of the soil as the curve shows, being fifty times as great plus 5 deg. Fahr. as at plus 32 deg. Fahr. This emphasizes the importance of installing ground electrodes well below the frost line. Where winters are very severe, this may be 6 or 7 feet below the surface.

(f) The electrical conductance of any soil is by means of the

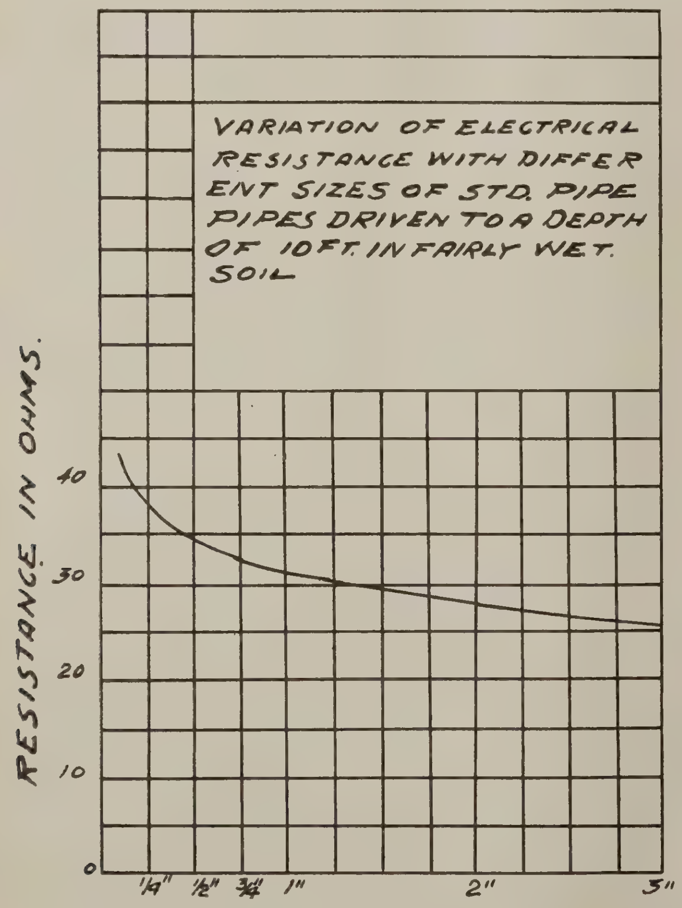


Fig. 2

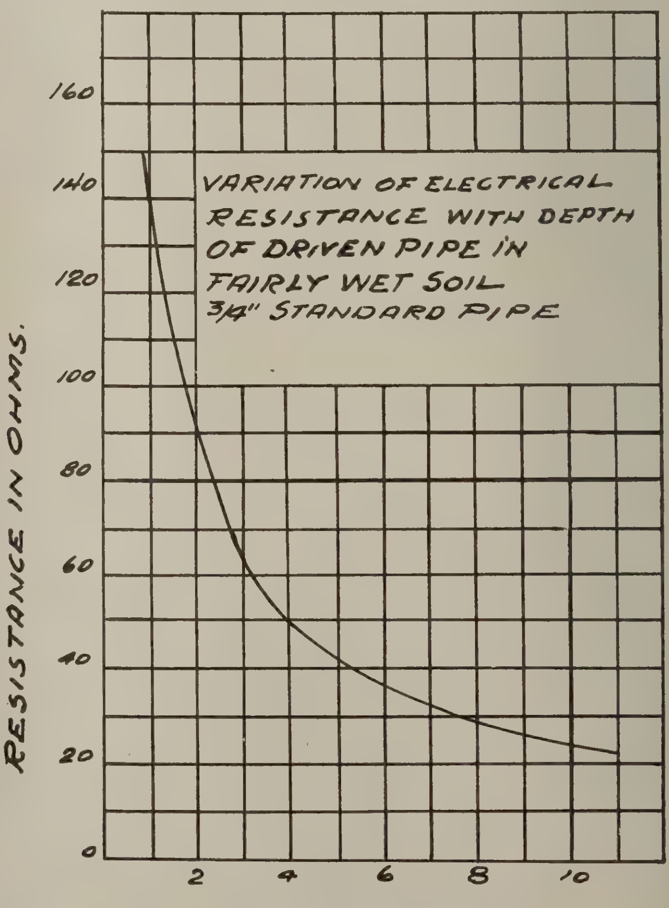


Fig. 3

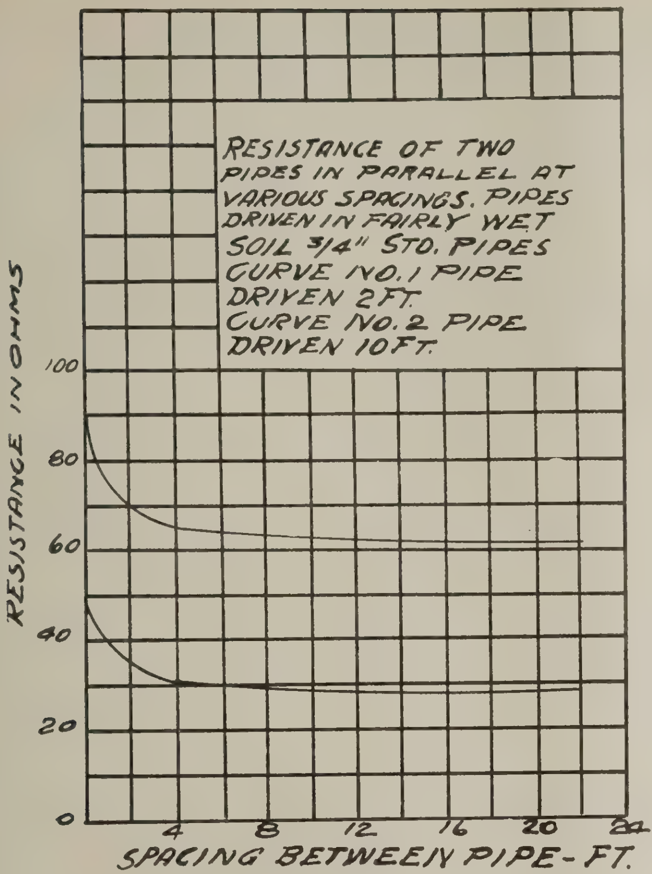


Fig. 4

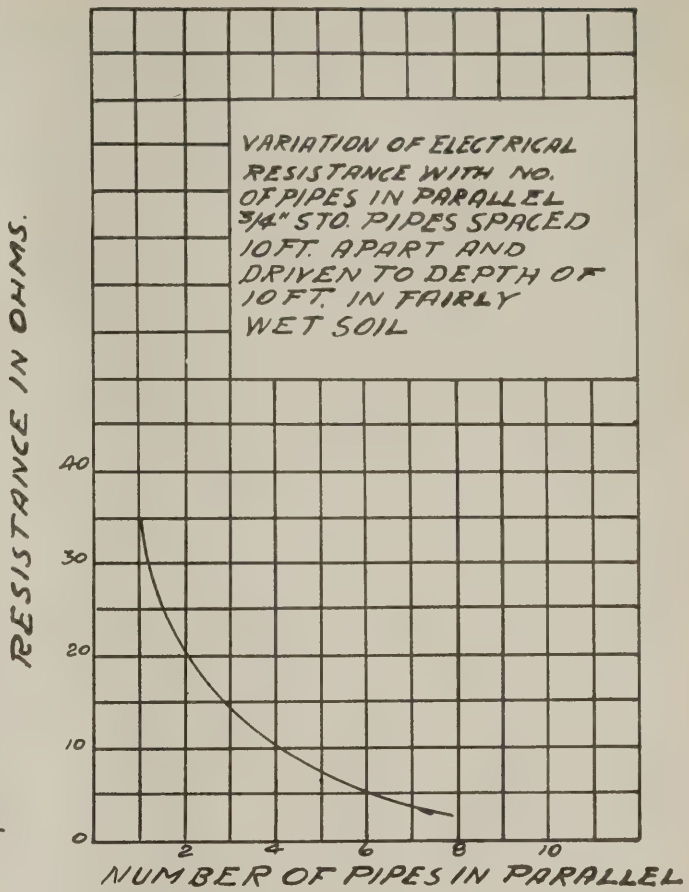


Fig. 5

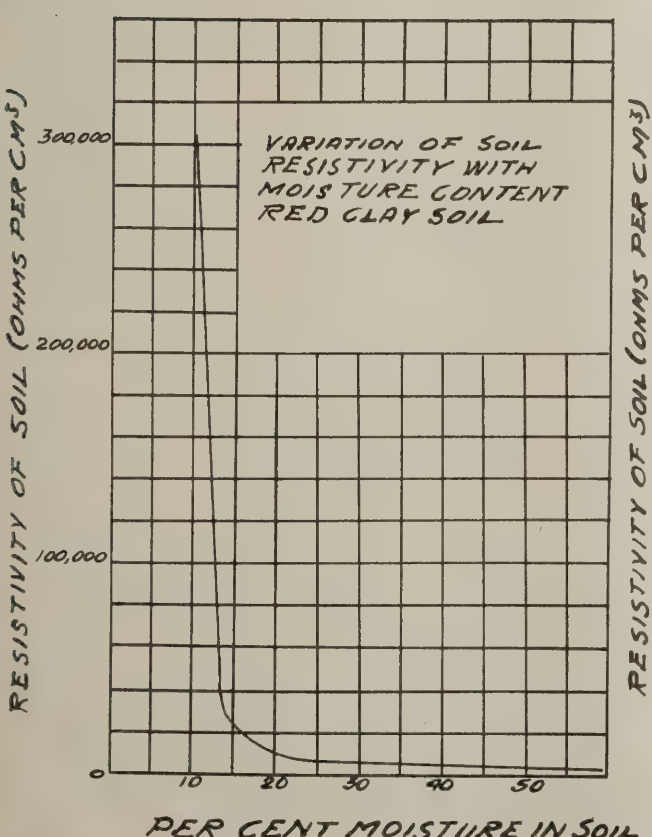


Fig. 6

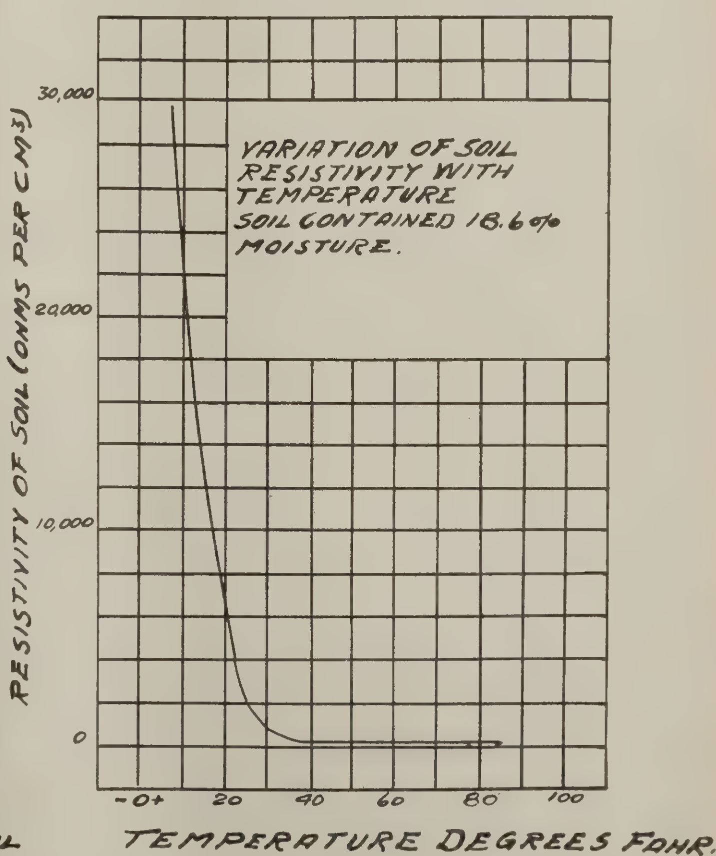


Fig. 7

electrolytes formed by moisture combining with the soluble acids, alkalies and salts, and where they are lacking their artificial introduction will show excellent results, as indicated by curve shown in Fig. 8. It will be noted that the curve flattens off at about 3 per cent salt in moisture, and further increases of salt effect but little decrease in the soil resistivity. The effect of salt differs, of course, for different kinds of soil.

In this curve 1 per cent of salt in moisture represents 0.27 pounds of salt per cubic foot of soil, which will give an idea of the amount of salt required in treating a ground connection. As previously stated, 90 per cent of the resistance of a driven pipe lies within a 6 to 10 foot radius around the pipe. Therefore, assuming the pipe driven to a depth of 8 feet, the salt treatment should be applied to a cylinder of earth at least 12 feet in diameter and 8 feet deep or a cubic capacity of 900 cubic feet. To make a half of 1 per cent solution for a soil having a 30 per cent moisture content, therefore, requires 122 pounds of salt. In applying salt to a driven pipe, a basin about 2 feet in radius and 1 foot deep should be excavated around the pipe, the salt poured in and then covered with a layer of earth and flooded with water, which will dissolve the salt and carry it deeper into the ground. For average soil conditions it is estimated that the salt around driven pipes should be renewed every two years.

Plate Grounds. Due to the greater difficulty and expense involved in installing plates for test purposes, the information on plate grounds is not as extensive as that available on pipe grounds.

In general it may be said that plates should be buried from 5 to 8 feet in conducting soil, since greater depths than these do not show a further marked decrease in resistance. There is also no economy in using a single plate of greater area than 20 square feet. Where two plates are used in parallel the minimum resistance for the two will be obtained where they are placed 25 to 30 feet apart.

The data on the effect of temperature and moisture content on ground resistivity given under pipe grounds, of course, also apply in the case of plate grounds.

Strip Grounds. Fig. 9 shows the relation between resistance and length of a strip ground. In burying a strip ground it is well to remember that for a given length of strip the wider the distribution the more effective the ground connection that will be obtained, which means that a strip should be buried in approximately a straight line. It appears from the data available on strip grounds that after a depth of 3 feet has been reached there will not be a further marked decrease of resistance with increasing depth.

References. Peters, O. S., Ground Connections for Electrical Systems. Bureau of Standards Technological Paper No. 108.

Towne, H. M. Lightning Arrester Grounds. Electrical World. Vol. 83, I p. 131-5, Jan. 19; II p. 183-7, Jan. 26, 1924.

APPENDIX B

Methods of Measuring Ground Resistance

There are a number of methods by which resistance measurements of ground connections can be made, the principal ones from the standpoint of practicability are:

(a) Voltmeter-ammeter method.
(b) Wheatstone Bridge method.

Voltmeter-Ammeter Method. This is the most reliable method of any for making resistance measurements, especially if alternating current is available. The equipment required and connection diagram are shown in Fig. 10. It will be noted that if the a. c. supply circuit is grounded a transformer is required in order to isolate the test ground from the ground on the supply circuit.

Where the resistance of only one ground connection is to be measured, there must be some auxiliary or reference ground either of known value or of negligible value to use in testing.

Where there are at least three grounds to be measured, a known auxiliary ground is not required. With the three grounds identified as *A*, *B* and *C*, the resistance of each ground can be determined by measuring the series of resistance of *A* to *B*, *B* to *C*, and *C* to *A*, and then solving the three simultaneous algebraic equations thus obtained.

The chief advantage of this method lies in the fact that comparatively high voltages and currents are used, and results are not affected by stray currents of any kind in the earth. The most accurate results are obtained when the individual ground connections all have approximately the same resistance.

The disadvantage of this method is that if a transformer is required, the outfit weighs so much that it is inconvenient to trans-

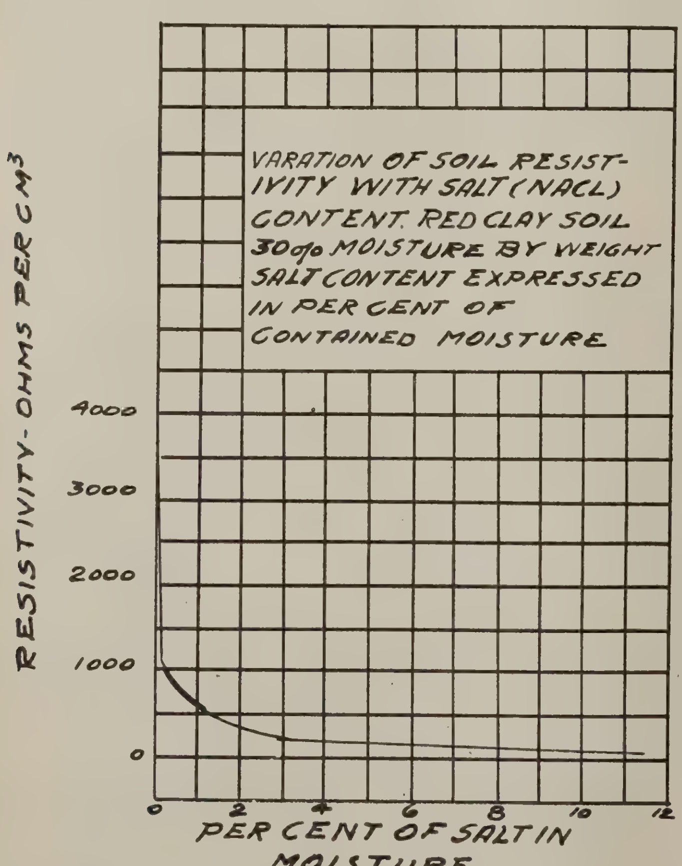


Fig. 8

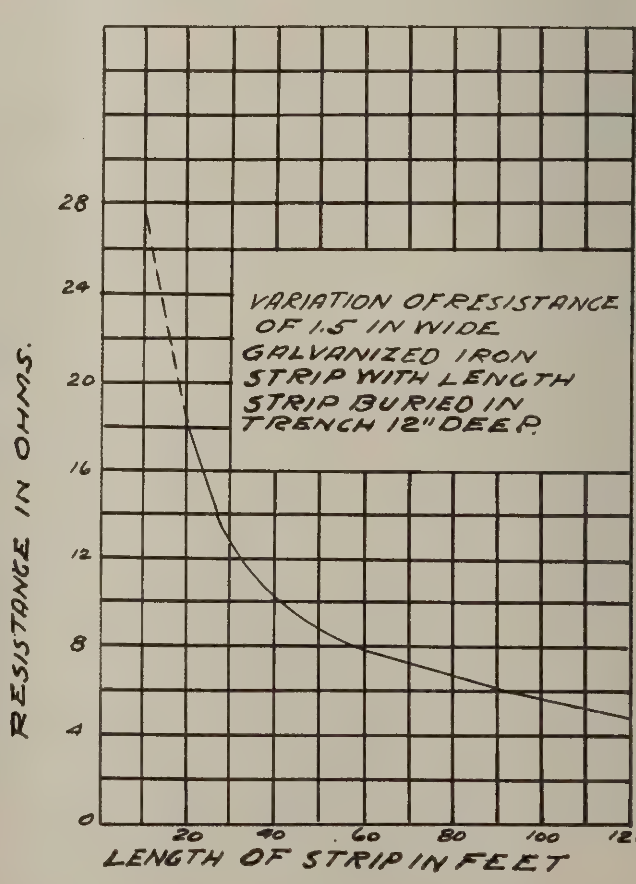


Fig. 9

port. Furthermore, it is limited in use to locations where a 110 or 220 volt supply circuit is available.

Wheatstone Bridge Method. The apparatus for this method consists of three dry cells in series, a four ohm buzzer, a push button, a very small transformer having about a 1:10 ratio, a Wheatstone bridge and a telephone receiver, all connected as shown in Fig. 11. The bridge should preferably be of the easily portable type used for field work. The telephone receiver should be of rather low sensitivity so as to be less affected by the disturbing effects of stray currents.

In making measurements with the bridge method, the procedure is the same as for the ammeter-voltmeter method; that is, with three ground connections under test, the resistance of each pair in series is measured and the individual resistances obtained from the solution of the simple algebraic equations.

The results obtained by the bridge method are accurate within 5 per cent, which is sufficient for practical purposes.

The principal advantages of the bridge method of measuring the resistance of ground connections are as follows:

(a) The source of energy constitutes a part of the apparatus, so it is not necessary to depend upon a low voltage supply circuit for measuring purposes.

(b) The outfit is easily portable and very rugged.

(c) Direct readings are obtained, doing away with the need for computations.

The disadvantages of the bridge methods are that:

(a) The test fails if for any reason alternating currents are induced from external sources into the ground circuit, because the induced currents will make the telephone receiver too noisy to make an accurate balance of resistance.

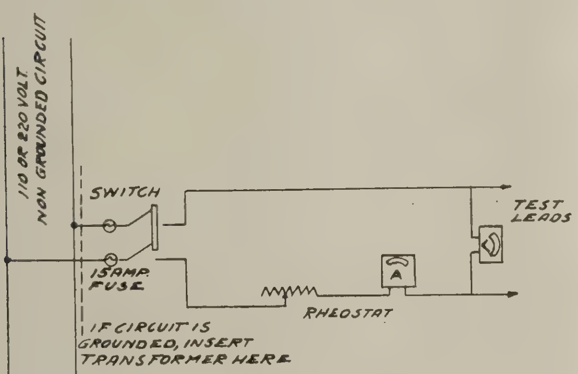
(b) No indication is given of the stability of the ground connection to dynamic currents.

Note—The section from the end of the 1st paragraph in the 1st column on page 312 to this point is reprinted from Serial Report of the Electrical Apparatus Committee (1925-1926), Technical National Section, National Electric Light Association, covering Practices and Methods in A. C. Substation Grounding, and is used by courtesy of the National Electric Light Association, 29 West 39th street, New York, N. Y.

Direct Current Distribution Systems. In three wire direct current systems the ground connections shall be made at the neutral at one or more supply stations.

In two wire direct current systems the ground connection shall be made at one station only.

No ground connection shall be made at individual services or



TEST CONNECTIONS FOR VOLTMETER AMMETER METHOD OF MEASURING RESISTANCE OF GROUND CONNECTION

Fig. 10

within the building served. In two wire systems the grounded side of the circuit shall be insulated from ground except at the station ground connections.

Alternating Current Distribution Systems. In alternating current systems the ground connection shall be made at the building service by direct ground connection through water piping system or artificial ground.

Where transformers supply a common set of mains, fuses shall be located only at such points as not to cause the loss of the ground connections after any fuses in the transformer circuits or mains have been blown.

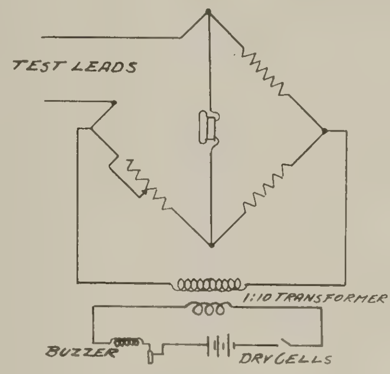
Alternating current secondary circuits supplied from a transformer outside the building shall not be grounded inside building except at the service entrance.

In single phase, three wire systems, the ground shall be on the neutral conductor. In single phase, two wire systems, the ground may be made on either conductor. In two wire, single phase and in two or three phase systems the ground shall be made at that point of the system which brings about the lowest voltage from ground unguarded current-carrying parts of the connected devices. Where only one phase of a two or three phase secondary system is employed for lighting, that phase should be grounded, and at the neutral conductor if one is used.

The grounded conductor of an interior wiring system shall have but one grounding connection within the building.

The secondary system ground shall be separate from the equipment, conduit, armored cable, metal raceway.

Current in Grounding Conductor. Grounds shall be so ar-



TEST CONNECTIONS FOR WHEATSTONE BRIDGE METHOD OF MEASURING RESISTANCE OF GROUND CONNECTION

Fig. 11

ranged that under normal conditions of service there will be no objectionable flow of current over the grounding conductor.

Where the objectionable flow of current over a grounding conductor is due to the use of multiple grounds, one or more of such grounds shall be abandoned or the location changed.

Equipment and Wire Runways. For conduit, metal raceways, generators, motors, transformers, and other equipment, the point at which the grounding conductor is attached shall, if practicable, be readily accessible.

No separate grounding conductor shall be required for non-current-carrying parts of equipment if grounded through the conduit, cable sheath, or metal raceways system of the building by means of standard locknuts and bushings or by a separate bond between the equipment and the conduit, or metal raceway system. The wiring shall conform to all requirements of the specifications applying to wires of the voltage of the circuit to which the grounding wire is attached.

For conduit or metal raceways the ground connection shall be as near as practicable to the point where the conductors in the conduit system concerned receive their supply.

Service Conduit. Where the service conduit is grounded, its grounding wire shall be run directly from it to the ground, no portion of the house conduit being used as a part of the grounding conductor.

Material and Continuity. In all cases the grounding conductor shall be of copper or of other metal which will not corrode excessively under the existing conditions and, if practicable, shall be without joint or splice. If joints are unavoidable they shall be made and maintained so as to conform to the resistance requirements of rules under ground resistance.

In no case shall a fuse or automatic circuit-breaker be inserted in the grounding conductor or connection except in a ground connection from equipment where its operation will result in the automatic disconnection from all sources of energy of the circuit leads connected to equipment so grounded.

For lightning arresters and ground detectors the grounding conductor shall be as short and straight as practicable and free from sharp bends.

Size and Capacity. The conductor, or conductors, for grounding circuits shall have a combined current capacity sufficient to insure the continuity and continued effectiveness of the ground

connection under conditions of excess current caused by accidental grounding of any normally ungrounded conductor of the circuit. No individual grounding conductor for electrical circuits shall have current capacity less than that of a No. 8 (0.128 inch) copper wire.

The grounding conductor for a direct current system shall have a current capacity not smaller than the largest feeder of the same system leaving the station.

The grounding conductor for alternating current systems shall have a current capacity not less than one-fifth that of the conductor to which it is attached, except that it need not be larger than No. 0 (0.325 inch) copper.

For lightning arresters the grounding conductor, or conductors, shall have a current capacity sufficient to insure continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual grounding conductor shall have less conductance than a No. 6 (0.162 inch) copper wire. The conductor grounding a lightning arrester shall not be connected to an artificial ground provided for circuits or equipment, but shall be kept at a distance of at least 20 feet when practicable.

For non-current-carrying parts of electrical equipment the conductance of a grounding conductor shall be not less than that provided by a copper wire of the size indicated in the following table. When there is no fuse or automatic circuit-breaker protecting the equipment, the size of the grounding conductor will be determined by the design and operating conditions of the circuit.

RATING OF FUSE OR CIRCUIT BREAKER WHICH PROTECTS EQUIPMENT OR CONDUCTORS

	Size of grounding copper wire	
	A. W. G.	Inches
Not more than 100 amperes	10	0.102
More than 100, but not more than 200 amp	6	0.162
More than 200, but not more than 500 amp	4	0.204
More than 500, but not more than 600 amp	2	0.258

FUSING CURRENT COPPER WIRE (AMPERES)

Size of wire	0000	000	00	0	2	4	6	8	10
Fusing current	3196	2684	2264	1895	1342	942	666	471	328
Size of wire	12	14	18	....	....	...	...	...	...
Fusing current	235	166	83	....	....	...	...	...	...

FUSING CURRENT ALUMINUM WIRE (AMPERES)

Size of wire	0000	000	00	0	2	4	6	8	10
Fusing current	2367	1987	1676	1403	994	698	493	349	243
Size of wire	12	14	18	....	....	...	...	...	...
Fusing current	174	123	61	....	....	...	...	...	...

In portable cord to portable equipment protected by fuses not greater than 15 amperes capacity, a No. 18 (0.040 inch) grounding wire may be used.

Grounding wires for conduit, or metal raceway systems shall have a conductance of at least equivalent to No. 10 (0.102 inch) copper where largest wire contained is not larger than No. 0 (0.325 inch) and need not be larger than No. 4 (0.204 inch) where the largest wire contained is larger than No. 0; and for service conduit the grounding wire shall have a conductance not less than that of No. 8 (0.128 inch) copper wire and need not be larger than No. 2 (0.258 inch) where the largest wire contained is larger than No. 0.

Mechanical Protection and Guarding Against Contact. Where exposed to mechanical injury the grounding conductor shall be protected by substantial conduit or other guard. Guards for lightning arrester grounding conductors shall be of non-magnetic material unless the grounding conductor is electrically connected to both ends of the guard.

If the resistance of the ground connection is in excess of three ohms, the grounding conductor, except in rural districts, shall be protected and guarded by being enclosed in insulating conduit or moulding to protect persons from injury by coming in contact with it.

Note—Such a high resistance may exist where artificial grounds are necessarily permitted in lieu of the preferable grounds to buried metallic water piping systems.

Mechanical protection and insulating guards should extend for a distance of not less than 8 feet above any ground, platform, or floor from which grounding conductors are accessible to the public.

A grounding conductor for a circuit shall be guarded as required for current carrying conductors of the circuit.

Exceptions.—(1) A grounding conductor for a circuit having multiple grounds, where such conductor is entirely outside buildings and has strength and current capacity not less than No. 6 (0.162 inch) copper wire.

(2) In stations substantial bare ground busses may be used.

Underground. Wires used for grounding conductors if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken, and shall have joints carefully painted or otherwise protected against corrosion.

The ground connection shall be permanent and effective, and be made as indicated below, but always to water piping systems, if available.

Piping Systems. For circuits, equipment, and arresters at supply stations, connections shall be made to all available active metallic underground water-piping systems between which no appreciable difference of potential normally exists, if the pipe is of sufficient capacity, and to one such system of appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system, if available. Gas piping should not be used for ground circuits.

Note—The protective grounding of electrical circuits and equipment to water pipe systems in accordance with these rules should always be permitted, since such grounding offers the most effective protection to life and property and is not injurious to the piping systems. Ground connections from circuits should not be made to jointed piping within buildings, except water piping.

Alternate Methods. Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. In many cases metal well casings, local metal drain pipes, and similar buried metal structures of considerable extent will be available and may be used in lieu of extended buried water piping systems.

In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other non-current-carrying surfaces should also then be connected. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require artificial grounding for steel frame buildings supported on masonry or concrete footings.

Artificial Grounds. When resort must be had to artificial grounds, their number should be determined by the following requirements:

(1) Not more than one such ground is required for lightning arresters, except where for large current capacity.

(2) At least two grounds are required for low voltage alternating current distribution circuits at transformers or elsewhere.

Grounds to Railway Returns. Protective ground connections should not be made to railway negative return circuits when other effective means of grounding are available, except ground connections from electric railway lightning arresters.

When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a grounded neutral with multiple grounds) between the railway return and the other grounded conducting bodies (such as buried piping and cable sheaths).

Note—This rule does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative return circuits for the prevention of electrolysis.

Multiple protective ground connections from other circuits to railway returns should be avoided, and where multiple artificial grounds are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, which flow would reduce their effectiveness, or otherwise cause damage.

Piping. Ground connections to metallic piping systems shall be made (except as permitted below) on the street side of water meters, which might interrupt the continuity of the underground metallic pipe systems, but connections may be made immediately inside building walls to secure accessibility for inspection and test. When water meters are located outside buildings or in concrete pits within buildings where piping connections are embedded in concrete flooring, the ground connections may be made on the building side of the meters.

Ground connections for equipment, or metal raceways, and the like, or as a multiple ground for alternating current secondaries, may be made to the water piping system at a point near the part to be protected, provided there are no insulating joints or fittings in the pipe to prevent a good ground. In such cases care should be taken to electrically connect all parts of the piping system liable to create a hazard (if they become alive) and the

pipe system shall be shunted where necessary around meters, etc., in order to keep the connection with the underground piping system continuous.

Gas piping systems within buildings should not be used for purposes of this rule, except that gas pipe need not be insulated from otherwise well grounded electrical fixtures, and where the making of another ground connection for a fixture would involve a long run and the fixture is, therefore, of course, not within reach of plumbing or plumbing fixtures, the gas piping may for small fixtures be utilized as the sole ground connection. Where gas piping is so used it must be bonded to the water piping system at the point of entrance of water piping.

Ground Clamps. The ground connections to metallic piping systems shall be made by means of an approved clamp firmly bolted to the pipe after all rust and scale have been removed, or by means of a brass plug which has been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or by other equivalent means.

The grounding conductor shall be attached to the clamp or to the plug by means of solder or by an approved solderless connector. The point of connection shall be as readily accessible as possible, and the position should be recorded.

Note—With bell-and-spigot-joint pipe it may be necessary to connect to several lengths where circuits or equipment of large current capacity are being grounded.

Contact Surfaces. If conduit, couplings, or fittings having protective coating of nonconducting material, such as enamel, are used, such coating shall be thoroughly removed from threads of both couplings and conduit and such surfaces of fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Grounded pipes shall be free from rust, scale, etc., at the place of attachment of ground clamps.

In ice houses, packing plants, etc., where a great deal of moisture is present and where conduits are attached to metal cabinets, cut-out, pull or junction boxes, compensators, etc., by means of standard locknuts and bushings, these conduits should be bonded together with approved ground clamps.

Artificial Grounds. Artificial grounds should be located where practicable below permanent moisture level. Areas where ground water level is close to the surface should be used when available.

Where copper ground plates are used, they should be at least 0.06 inches thick. When driven pipes are used, they should be of galvanized iron and not smaller than three-fourths inch internal diameter, and when cast-iron plates are used they should be at least 0.25 inches thick.

Limits. The combined resistances of the grounding wire and the connection with the ground shall not exceed 3 ohms for water pipe connections nor 25 ohms for artificial (buried or driven) grounds. Where it is impracticable to obtain with one ground, artificial ground resistance as low as 25 ohms, this requirement shall be waived, and two artificial grounds, at least six feet apart and with combined area of not less than four square feet, shall be provided.

Grounding Conductors. Grounding conductors from equipment and circuits of each of the following classes, when required by these rules, shall be run separately to the ground:

(1) Lightning Arresters.

(2) Secondaries connected to low voltage lighting or power circuits.

(3) Secondaries of current and potential instrument transformers and cases of instruments on these secondaries.

(4) Frames of direct current railway equipment and of equipment operating in excess of 150 volts and which is accessible to other than qualified persons.

(5) Frames of utilization equipment or wire runways other than covered by item (4), except that if a secondary distribution system has multiple grounds to water piping, service conduits may utilize the same grounding conductors.

(6) Lightning Rods.

Arrester Grounds. Lightning arrester ground connections shall not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipment, but should be well spaced and, where practicable, at least 20 feet from other artificial grounds.

Location. Where required, lightning arresters shall be attached to all undergrounded sides of system connected to overhead circuits except circuits in cables with grounded metal sheath.

Indoors. Lightning Arresters with auxiliaries, when installed inside of buildings shall be located well away from all other equipment, passageways, and combustible parts of buildings. When of a type containing oil the necessary safety precautions depend largely on whether they are located in buildings or outdoors.

Air Break Disconnectors. Lightning arresters on circuits of more than 7,500 volts shall be so arranged, isolated, and equipped that they may be readily disconnected from conductors to which they are connected by air-break manual disconnectors, having air gaps of not less than four times the equivalent needlepoint sparking distance in air of the operating voltage of the circuit to which the arresters are connected, and never less than eight inches.

These disconnecting devices should be installed at a sufficient distance from all parts of the arrester equipment to make it safe to perform maintenance and inspection work on any part of the arrester.

Working Space. Such disconnectors, unless remotely controlled and operated, shall have adequate and readily accessible working space with secure footing, which shall be maintained about all electrical parts or equipment which require adjustment or examination when exposed while in service.

Ground wires shall be run as directly as possible and shall be of low impedence and ample current capacity.

Kinks, coils, and sharp bends in the wires between the arresters and the outdoor lines shall be avoided as far as possible.

All non-current-carrying metal parts of arresters shall be grounded unless effectively isolated by elevation or guarded as required for live parts of the voltage of the circuit to which the arrester is connected.

Protection from Contact or Arcing. All current-carrying parts of arresters or circuits of more than 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them or from injury by arcing.

Making Adjustments. Lightning arresters, unless provided with disconnectors which are always opened before work is done on the arresters, shall be so arranged that necessary adjustments are possible (without approach to current carrying parts) through the use of permanently grounded mechanism or suitable insulating appliances. Where charging or adjustment must be done with arresters alive, permanently grounded mechanisms or suitable insulating appliances shall always be provided.

Insulation of Attachments. All choke coils, gap electrodes, inherent to the lightning protective equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

BATTERY CHARGING PLANTS

This report will take up battery charging for the following services: Industrial Trucks, Standby Emergency, Car Control, Bus Control, and Supervisory Control. This is done in order to avoid repetition, as other Committees have reported on Car Lighting Facilities, Train Control, Signal, and Telegraph & Telephone services.

It is advisable that all tractor batteries have the same number of cells, and that in small plants the same type of battery be used.

When a plant is installed it is advantageous to have charging panels designed for use with either lead or nickel iron batteries.

With the exception of the standby emergency battery, there is little reason for special wiring, as the type of battery used requires very few repairs, and no special facilities for battery repairing are recommended. This is in accordance with economy in installation and maintenance.

It is essential to protect all types of batteries against severe cold. In order to show the effect of temperature on capacity, and freezing of electrolyte for lead batteries, Figs. 1 and 2 are attached. Lack of information as to how far the voltage of a cell may be permitted to drop without seriously affecting the capacity is a source of confusion. Figs. 3 and 4 show a comparison of voltage and capacity of batteries.

General Requirements for Room Where Batteries are Located, Charged, or Worked On

It is important that there should be space enough in all battery rooms to allow of access to all the cells. This is es-

pecially the case where large cells are used and in this case, if possible, access from both sides of the cells should be provided.

The amount of exposed iron or metal work in the battery room should be reduced to a minimum. Any that must be in the battery room should be protected with acid resisting paint. Ample light is also desirable so that batteries can be properly inspected, and in this connection it would be well, if the wall and ceiling are to be painted, to have them painted with a light tint, so as to help the lighting. The room should preferably have a normal temperature of 70 degrees Fahrenheit, and if necessary, a heating and ventilating system should be provided to accomplish these results.

Floors

The best acid resisting floor which can be used in a battery room is what is known as a "mastic" floor.

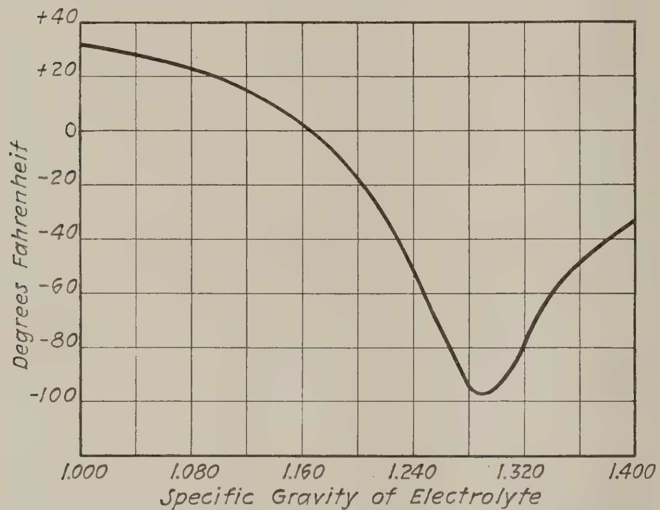


Fig. 1—Freezing Point of Sulphuric Acid Solution Electrolyte for Lead Batteries

This consists of a floor, all the materials used in the making of which, such as grit, sand, asphalt, etc., are absolutely unaffected by dilute sulphuric acid of 1400 specific gravity.

Two types of mastic floor are recommended, one using a double membrane to be used where there is another room directly under

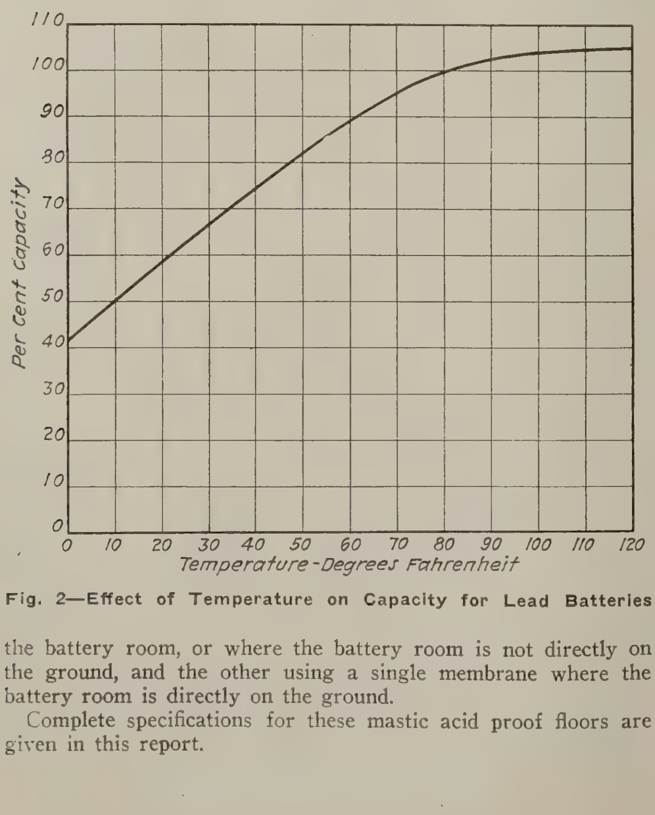


Fig. 2—Effect of Temperature on Capacity for Lead Batteries

the battery room, or where the battery room is not directly on the ground, and the other using a single membrane where the battery room is directly on the ground.

Complete specifications for these mastic acid proof floors are given in this report.

In the case of small battery rooms, a cement floor may be used particularly if it is on a ground floor, or in a basement where there is no structural work underneath, but this is not so good in its acid resisting qualities as the floor described above. Where a cement floor is used it is recommended that air slacked lime be used to keep it dry. Under certain conditions it is also

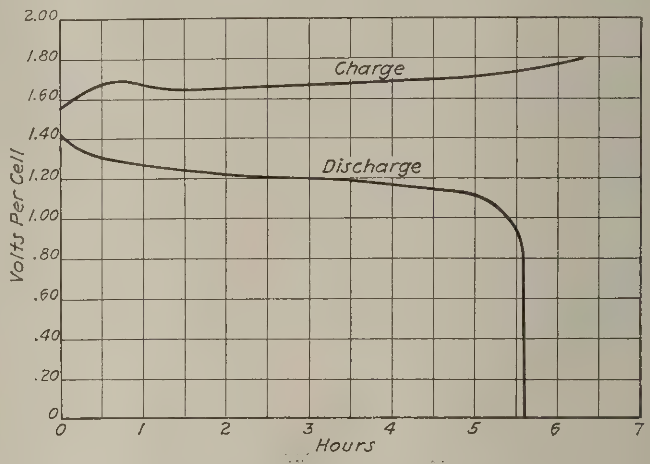


Fig. 3—Normal Charge and Discharge on Seven Hour Rate for Nickel Iron Battery

recommended that a cement floor be given several coats of an acid resisting paint.

Ventilation

The best means of ventilating a battery room is to secure a steady circulation of air through the same, by providing inlets at one end of the battery room, preferably near the floor, and an outlet at the farther end, preferably near the ceiling. An excessive circulation is not required and is, moreover, objection-

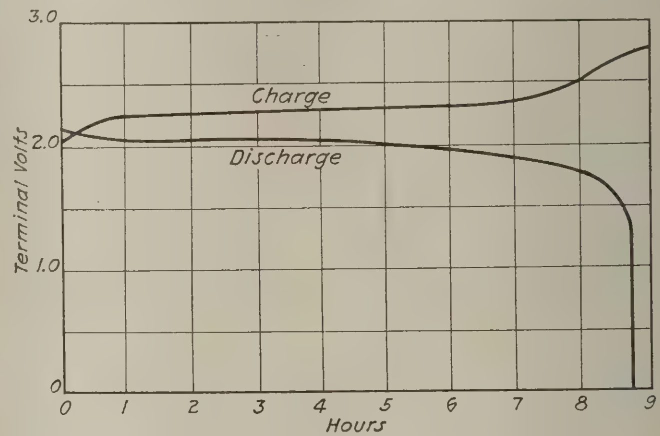


Fig. 4—Charge and Discharge Curves for Lead Cell

able, as it will tend to increase the evaporation of water from the cells. Where the natural draught is not enough to produce this circulation, a suitable fan can be installed at the outlet to draw the air from the room. Where necessary, a screen box with a perforated lead screen can be placed at the outlet so as to collect the acid spray and fumes. In battery rooms of restricted dimensions which contain relatively large batteries, a change of the total volume of air four times an hour will provide good ventilation. For smaller batteries or where the gassing of batteries is not severe, the rate of change can, of course, be reduced.

Heating

It is advisable that battery rooms be maintained at a normal temperature of 70 degrees, and, if necessary, a heating system should be supplied to maintain this temperature. Hot water, hot air or steam is necessary, as no stove or open fire is allowable in a battery room. In some cases, where heat is only required for a short period of the year, electric heaters will be found economical, one advantage being that they require no attendant.

Where a battery is located near an engine room, it can often be heated by drawing air from the engine room into the battery room, thus heating the latter and cooling the former. Of course, this connection must be shut off during the summer time, other provision being made for getting cool, fresh air into the battery room.

Water Supply

It is advisable in all battery rooms to have a water supply to fill up the cells from time to time replacing the water which has evaporated.

Charging Equipment

Suitable current for charging storage batteries may be obtained from a direct circuit or from an alternating current circuit through suitable transforming or rectifying apparatus.

In determining the choice of charging equipment the conditions as to source of power may be classified as follows:

(1) *Constant voltage d.c. source available.*

Use existing d.c. circuit if voltage is suitable. If voltage is too low, use booster or motor generator set. If voltage is too high use resistance (if current required is small) counter e.m.f. cells, balancer set or motor generator.

(2) *Alternating current source available.*

Convert to direct current at suitable voltage with a motor generator set, rotary converter, mercury arc rectifier, or hot cathode rectifier. For charging batteries in electric motive power vehicles, it is desirable that the charging be entirely automatic such as the modified constant voltage method. This system consists of either a practically constant voltage direct current but with a suitable fixed resistance in each charging circuit, or an individual charging machine for each circuit with a drooping characteristic equivalent to that due to the fixed resistance.

Such a combination will give a comparatively high rate of charge at the beginning which is gradually and automatically tapered as the charge progresses so as never to exceed a safe value.

In the above system the automatic charge cut off is obtained by means of an ampere hour meter.

In stationary batteries the charging equipment is usually governed by local conditions and the battery manufacturers will be glad to advise regarding particular installations.

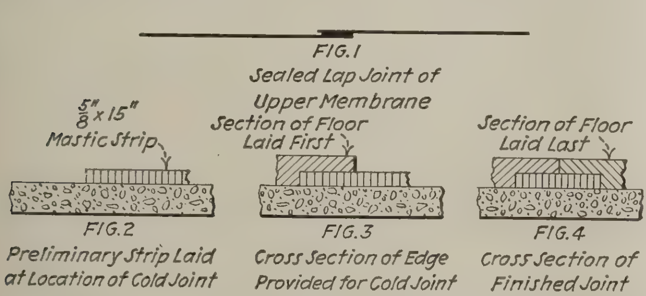
SPECIFICATIONS FOR ACID PROOF MASTIC BATTERY ROOM FLOOR USING DOUBLE MEMBRANE

Revised July 20, 1925

NOTE: These specifications are recommended where there is another room directly under the battery room, i. e. battery room *not* directly on the ground, or where an acid leak into the building structure or foundations might be a serious matter.

General

The floor in general shall consist of a wearing surface of acid proof mastic underneath which is laid two separate acid proof



Sketches Showing Method of Laying Floors

membranes, the upper thoroughly sealed to the under surface of the mastic and the lower sealed tightly to the concrete floor by means of hot liquid asphalt, and the two membranes being separated by a double layer of oiled paper which acts as a slip-joint and also permits of repairs being made to the wearing surface in case of mechanical damage, without destroying both membranes.

All materials used in the making up of the mastic, i. e. the grit, sand, asphalt, etc. shall be absolutely unaffected by dilute sulphuric acid of 1.400 specific gravity. The felt used for membranes shall be rag felt saturated and coated as thoroughly as possible with acid resisting compound and samples of all these materials shall be tested and approved by the owner before being used in the floor.

The condition under which these acid proof floors are used requires that they shall be not only completely acid resisting, so as to absolutely protect the steel and concrete underneath, but shall also be capable of carrying heavy loads without appreciable marking, and tests as specified later will be made on each section of the floor as laid in order to determine whether it is hard enough to carry the loads required.

Concrete Floor

The concrete floor must be smooth with a surface at least equal to a broomed surface, free from humps, projections or hollows.

It is recommended in general that floors be perfectly level, with a drain for use as a floor sink for washing parts during repair work. It is not contemplated that the mastic floor ever be washed as the less water present the better, powdered air-slacked lime being used to keep the floor dry and neutralize any acid.

However, the concrete floor must follow accurately any slopes and drainage lines if such be called for in drawings and specifications.

Revised 8-15-25

Particular care shall be exercised in setting the drain boxes or sump pits so that drainage shall be complete and that there shall be no chance of leakage around the drain boxes.

Lower Membrane

The lower membrane shall consist of two plies of light weight asphalt-saturated and coated rag felt. A portion of the floor shall first be treated with a suitable primer to insure a bond and then mopped with hot liquid asphalt and the first layer of felt immediately applied while the asphalt is still hot, and the felt thoroughly rolled until it is tightly stuck to the concrete floor, successive sections being similarly laid until the entire floor is covered. The joints between adjacent strips are to be lapped 3 in., thoroughly bonded with hot asphalt.

This layer of felt shall then be thoroughly mopped with hot asphalt and the second layer of felt applied and rolled down while the asphalt is still hot. The joints of this second layer of felt are to be so spaced that the joints of the two layers are one-half of the width of the roll apart. When completed, this layer of felt also is to be mopped with hot asphalt, particular care being taken that its entire surface is completely and thoroughly coated.

Both layers of this membrane shall be turned up along all walls and around all columns to a height of not less than 6 in. and the lower layer thoroughly stuck to the wall and column with hot asphalt. In turning up this membrane, great care must be taken to see that it is not cracked or torn in the angle at the junction of the floor with the wall or column.

Oiled Paper

When this lower membrane is completed and the asphalt with which it is flooded has cooled and hardened, two layers of oiled paper shall be laid thereon, with broken joints, to serve as a slip-joint between the lower and upper membranes. This oiled paper shall be 36 in., 50 pound, oil kraft paper.

Upper Membrane

Upon the layer of oiled paper the upper membrane is laid in one layer. The oiled paper and the upper side of this membrane are *not* to be mopped.

Joints are to be lapped about 6 in. and sealed with hot asphalt for 3 in. only, 3 in. back from the edge of the upper piece, Fig. 1.

None of the asphalt used for this seal should show on the upper surface of this membrane, as if present, it is taken up by the hot mastic when this is laid, producing soft spots in the floor.

This upper membrane is to be turned up for a height of 8 in. around all walls and columns in the same manner as the lower membrane, and is to be thoroughly bonded to the lower membrane with hot asphalt at these points.

Mastic Floor

The mastic wearing surface is to be laid in one layer, approximately 1¼ in. thick. The greatest care is to be taken in

laying this mastic that all the joints are as nearly perfect as possible, and where the floor already laid is even slightly cooled, sufficient hot mastic is to be piled up over the old work at these joints to insure its being sufficiently soft to obtain a perfect bond for the full depth of the mastic.

At all points where a joint is to be made *after* the mastic first laid has *cooled,* a strip of mastic about 15 in. wide and ⅝ in. thick will first be laid, as shown in Fig. 2.

The edge of the 1¼ in. mastic layer, to be laid first, will then be carried half way across this strip as shown in Fig. 3, sufficient heat being applied to insure a perfect horizontal bond between the half of the 15 in. strip and the lap of the second being worked on. When the second section is laid, completing the joint, as shown in Fig. 4, sufficient heat must be applied so that the lap of the second section makes a perfect horizontal bond with the remaining half of the 15 in. strip, and the vertical joint between the laps of the two sections must be made as perfect as possible by piling hot mastic as specified in first paragraph, until the bond can be secured.

The mastic shall consist of acid resisting mastic block with the proper mineral ingredients, a mineral aggregate consisting of broken quartz, not over ⅜ in. size, and silica sand or pebble and sand gravel, or other approved mineral, and a natural asphalt flux. All of these materials are to be submitted to test for acid resistance as described under "Tests." The mixture shall be so proportioned as to have a maximum of mineral and a minimum of flux without resulting in checking or ravelling of the finished floor surface, so as to provide as hard a floor as possible.

All minerals shall be thoroughly dry before being placed in the melting kettle and the mixture shall be constantly stirred to insure complete coating of the mineral with the asphalt and to prevent the accumulation of mineral in the bottom of the kettle. No burnt material shall be used in the floor. The hot mixture shall be rubbed smooth with fine sand, and particular attention given to obtaining a perfect joint between the different batches of material.

Where the mastic floor is to meet the concrete floor on the level, the concrete floor under the mastic protected portion shall be cut out on a slope from a depth of 1 in. at the meeting line to zero, 18 in. back under the mastic, and the mastic surface shall then be brought down in this cut to a level with the concrete.

Cove

A cove 12 in. high by approximately 1 in. thick shall be applied along all walls and columns. This cove can be of a much richer mix than the mastic used in the floor, as it does not have to carry load. Extreme care must be exercised to obtain a thorough bond and an absolutely acid tight joint between the surface of the floor and the cove.

This cove shall be formed by applying expanded metal lath to the wall or column, this being so fixed that it will adhere tightly and smoothly to the wall, and the mastic then plastered on to this. Great care must be taken to see that at no point shall the metal lath reach the surface of the mastic, as this would form a lead for acid to work in by attacking the metal.

The top of this cove shall be finished with a bevel of approximately 45 deg. to prevent any acid from lying thereon.

Drains

The owner will provide drain boxes of lead alloy with a projecting lead apron. These drain boxes will be set by the mastic contractor after the lower membrane has been completed and the lead apron shall be thoroughly sealed to the upper surface of the lower membrane with hot liquid asphalt. A back flashing, consisting of one layer of membrane shall then be applied over the lead apron and extending not less than 18 in. out from it in all directions. This entire back flashing being most thoroughly and carefully sealed to the lower membrane, and the lead apron with hot asphalt. The top membrane and the mastic itself shall be finished with the closest possible joint to the lead flange of the drain box.

TESTS

Tests for Acid Resistance

Samples of acid resisting material must be submitted, where asked for, to be tested for resistance to sulphuric acid having a specific gravity of 1.400. Also all material used in the construction of this floor will be tested on the job before the construction is proceeded with by submitting it to test in 1.400 sulphuric acid. The membrane and asphalt must be unaffected when immersed in the acid, and afterwards when taken out and allowed to dry, and the acid shall show no discoloration. The mastic block and flux must stand a similar test and the mineral aggregate when immersed in acid should produce no sign of activity, such as gassing, nor should there be any sign of solubility, and only a minimum discoloration of the acid. Any materials not passing these tests will be rejected and it will not be permissible to use them in the construction of the floor.

Test for Hardness

The finished floor shall be as hard as possible without showing cracks or porous spots. It must be able to support for twenty-four hours a load of 1620 pounds, supported on a 9 in. square tile, without showing more than 1/16 in. depression, in a room temperature of 90 deg. Fahrenheit.

SPECIFICATIONS FOR ACID PROOF MASTIC BATTERY ROOM FLOOR

ONE LAYER OF FELT. ONE LAYER OF MASTIC.

General

The floor in general shall consist of a wearing surface of acid proof mastic underneath which is laid one layer of acid proof double coated membrane.

All materials used in the making up of the mastic, i. e. the grit, sand, asphalt, etc. shall be absolutely unaffected by dilute sulphuric acid of 1.400 specific gravity. The felt used for membranes shall be 28-30 lb. rag felt saturated and coated as thoroughly as possible with acid resisting compound, and samples of all these materials shall be tested and approved by the owner before being used in the floor.

The conditions under which these acid proof floors are used require that they shall be not only completely acid resisting, so as to absolutely protect the steel and concrete underneath, but shall also be capable of carrying heavy loads without appreciable marking, and tests as specified later will be made on each section of the floor as laid in order to determine whether it is hard enough to carry the loads required.

Revised Aug. 25, 1925

Concrete Floor

The concrete floor must be smooth with a floated surface free from humps, projections or hollows, and must follow accurately the slopes and drainage lines called for in drawings and specifications.

Particular care shall be exercised in setting the drain boxes or sump pits so that drainage from the floor shall be complete and that there shall be no chance of leakage around the drain boxes.

Membrane

The membrane shall consist of one layer of asphalt saturated and coated rag felt (28-30 lb).

A portion of the floor shall first be treated with a suitable primer to insure a bond and then mopped with hot liquid asphalt and the first layer of felt immediately applied while the asphalt is still hot, and the felt thoroughly rolled until it is tightly stuck to the concrete floor; successive sections being similarly laid until the entire floor is covered.

Joints are to be lapped about 6 in. and sealed with hot asphalt for 3 in. only, 3 in. back from the edge of the upper piece, Fig. 1.

Revised Aug. 25, 1925

None of the asphalt used for this seal should show on the upper surface of this membrane, as if present, it is taken up by the hot mastic when this is laid, producing soft spots in the floor.

This layer of felt shall be turned up along all walls and around all columns to a height of not less than 3 in.

This shall be re-inforced with a second flashing strip of felt, turned up to the same height on the wall and extending out 12 in. on the floor. Both of these layers of flashing to be thoroughly sealed to wall and to each other for upper 6 in. with hot asphalt.

In turning up this membrane great care must be taken to see that it is not cracked or torn in the angle at the junction of the floor with the wall or column.

Mastic Floor

The mastic wearing surface is to be laid in one layer, approximately 1¼ in. thick. The greatest care is to be taken in laying this mastic that all the joints are as nearly perfect as possible, and where the floor already laid is even slightly cooled, sufficient hot mastic is to be piled up over the old work at these joints to insure its being sufficiently soft to obtain a perfect bond for the full depth of the mastic.

Revised Aug. 25, 1925

At all points where a joint is to be made after the mastic first laid has cooled, a strip of mastic about 15 in. wide and ⅝ in. thick will first be laid, as shown in Fig. 2.

The edge of the 1¼ in mastic layer, to be laid first, will then be carried half way across this strip as shown in Fig. 3, sufficient heat being applied to insure a perfect horizontal bond between the half of the 15 in. strip and the lap of the section being worked on. When the second section is laid, completing the joint, as shown in Fig. 4, sufficient heat must be applied so that the lap of the second section makes a perfect horizontal bond with the remaining half of the 15-in. strip, and the vertical joint between the laps of the two sections must be made as perfect as possible by piling hot mastic as specified in first paragraph, until the bond can be secured.

The mastic shall consist of acid resisting mastic block with the proper mineral ingredients, a mineral aggregate consisting of broken quartz, not over ⅜ in. size, and silica sand or pebble and sand gravel, (or other approved mineral such as Joplin Chat, obtained in Joplin, Mo.) and a natural asphalt flux. All of these materials are to be submitted to test for acid resistance as described under "Tests." The mixture shall be so proportioned as to have a maximum of mineral and a minimum of flux without resulting in checking or ravelling of the finished floor surface, so as to provide as hard a floor as possible.

All minerals shall be thoroughly dry before being placed in the melting kettle and the mixture shall be constantly stirred to insure complete coating of the mineral with the asphalt and to prevent the accumulation of mineral in the bottom of the kettle. No burnt material shall be used in the floor. The hot mixture shall be rubbed smooth with fine sand and particular attention given to obtaining a perfect joint between the different batches of material.

Where the mastic floor is to meet the concrete floor on the level, the concrete floor under the mastic protected portion shall be cut out on a slope from a depth of 1 in. at the meeting line to zero, 18 in. back under the mastic, and the mastic surface shall then be brought down in this cut to a level with the concrete.

Fillet

A 45 deg. fillet extending 3 in. above the finished floor surface shall be applied along all walls and columns. This fillet shall be of the same consistency as the main body of the mastic floor and shall be formed as a part of the floor at the time that the mastic floor is laid. In other words, there should be no joint between the ending of the mastic on the horizontal surface and the starting of the fillet which is to extend 3 in. up the wall. This fillet shall completely cover the upper edge of the turned up membrane.

Drains

The owner will provide drain boxes of lead alloy with a projecting lead apron. These drain boxes will be set by the building contractor and the mastic contractor shall thoroughly seal the lead apron to the upper surface of the membrane with hot liquid asphalt. A back flashing consisting of one layer of membrane shall then be applied over the lead apron and extend not less than 18 in. out from it in all directions, this entire back flashing being most thoroughly and carefully sealed to the membrane and the lead apron with hot asphalt. The mastic itself shall be finished with the closest possible joint to the lead flange of the drain box.

TESTS

Tests for Acid Resistance

Samples of acid resisting material must be submitted, where asked for, to be tested for resistance to sulphuric acid having a specific gravity of 1.400. Also all material used in the construction of this floor will be bested on the job before the construction is proceeded with by submitting it to test in 1.400 sulphuric acid. The membrane and asphalt must be unaffected when immersed in the acid, and afterwards when taken out and allowed to dry, and the acid shall show no discoloration. The mastic block and flux must stand a similar test and the mineral aggregate when immersed in acid should produce no sign of activity, such as gassing, nor should there be any sign of solubility, and only a minimum discoloration of the acid. Any materials not passing these tests will be rejected and it will not be permissible to use them in the construction of the floor.

Test for Hardness

The finished floor shall be as hard as possible without showing cracks or porous spots. It must be able to support for twenty-four hours a load of 1620 pounds, supported on a 9 in. square tile, without showing more than 1/16 in. depression, in a room temperature of 90 deg. Fahrenheit.

LEAD ACID STORAGE BATTERIES

Storage batteries of the lead acid type are assembled in three general ways, in glass jars, in sealed rubber jars and in lead lined wood tanks.

Glass jar batteries may be either of the open jar type or up to certain sizes may be of the sealed in type. Open glass jar batteries are generally used in situations where the battery is stationary and where space is available for the necessary battery room. The advantages of the open glass jar type are that the open top and transparent jar facilitate inspection and repairs. Open glass jar batteries are shipped knocked down and are assembled and given their initial charge on the ground.

Sealed glass jar batteries do not require a separate battery room and in the smaller sizes can be shipped assembled, sealed and charged with the electrolyte in the cells ready to go into service when received. Sealed glass jar batteries have the advantage of effectually preventing any acid spray from escaping from the cells but are somewhat harder to work on when repairs are required.

Wood lead lined tank batteries are used for stationary services where the capacities required are too large to be obtained from the glass jar type as satisfactory glass jars can only be manufactured up to certain sizes.

Sealed rubber jar type batteries are used in services where portability is required, where only limited space is available, or where conditions such as excessive vibration would preclude the use of a glass jar type.

In all the above batteries the plates may be of two general types, the Planté or formed type and the Faure or pasted type. The Planté or formed plate is heavier and occupies more space than the pasted type of equivalent capacity and is generally used where space and weight are not important factors.

In railroad service, batteries of the glass jar type are either open or closed and of the lead lined wood tank type are generally used for the following classes of work: Automatic Signals, Interlocking Switches, Telegraph, Telephone, Standby Emergency, Oil Switch, Bus Control and Supervisory Control.

Batteries of the sealed in rubber jar type may also be used in the above services and in addition are used for: Carlighting, Industrial Trucks and Tractors, Locomotives, Car Control and Train Control.

In the installation of the above batteries, the following general conditions should be observed.

Unpacking and Care of Material

If the battery is received in crates or packing boxes, care should be taken in the unpacking of the battery or handling of the parts. In knocked down batteries many of the parts may be easily broken or bent out of shape by rough handling. In assembled batteries keep the cells right side up to avoid spilling of electrolyte. Also if a broken jar is found, do not allow the plates to dry. Keep them covered with water. Do not lift sealed glass jar cells by the terminals.

Wood separators when shipped separately are shipped wet and should not be allowed to dry under any circumstances. If shipped in wood packing cases they should be left in the packing cases and kept wet by being frequently sprinkled with water at least once per week, the lid of the case being removed while sprinkling.

If a supply of wet separators is to be kept on hand for any length of time, they should be kept completely immersed in a vessel of water to which electrolyte of any specific gravity be-

tween 1.200 and 1.300 has been added in the proportion by volume of one part of electrolyte to nine or ten parts of water. The vessel (which must not be of metal unless of lead) should be covered to keep out impurities. An extra jar makes an excellent container.

Electrolyte

A battery shipped with electrolyte in the cells has been given an initial charge. It is shipped in a fully charged condition and with the proper amount of electrolyte in each cell. Electrolyte used in the lead acid type of battery is especially pure dilute sulphuric acid of a gravity depending on the type of cell in which it is used. As it is essential that acid should be practically free from impurities such as iron, nitrates or hydrochloric acid, it is recommended that the electrolyte be purchased from the manufacturer of the storage batteries. If sulphuric acid of 1.835 specific gravity or 66 degrees Baumé (oil of vitriol) is purchased, it may be reduced to the desired specific gravity by mixing with suitable water but in order to avoid possible injury from acid burns when mixing oil of vitriol, acid of 1.400 specific gravity is recommended. When mixing, slowly pour the acid into the water not the water into the acid and thoroughly stir with a wooden paddle. A metal vessel (unless of lead) must not be used for mixing or handling the solution. A glazed earthenware crock or a lead lined tank is suitable. A wooden vessel which has not been used for any other purpose, such as a new washtub, can be used for mixing, but not for storing the electrolyte.

Location of Batteries

Battery room or compartment must be well ventilated, but in such a way as to keep out water, oil, dirt, etc. It should also be dry and if practicable, moderate in temperature.

Locate and install the battery so that all cells are readily accessible for adding the water necessary to replace loss from evaporation. All exposed metal work other than lead should be painted with at least two coats of asphaltum paint.

Batteries in service on moving vehicles should have the trays seated firmly and evenly without any undue twisting and straining. Connecting cables must be flexible and sufficiently long to prevent a pull on the battery terminals.

In the operation of the above batteries, the following general conditions should be observed:

Cleanliness

Keep the battery and surrounding parts dry and clean. Cleanliness of the exposed battery parts is very necessary.

If electrolyte is spilled or surrounding parts are damp with acid, apply a solution of cooking soda and water in the proportion of one pound of soda to one gallon of water. Then rinse with water and dry. Do not allow soda solution to get into the cells. Soda solution or ammonia will neutralize the effect of acid on clothing, cement, etc.

Whenever trays, tanks, or other parts are repainted they should actually be lost due to spillage or similar causes.

Level of Solution

During operation, water evaporates from the electrolyte and must be replaced regularly by suitable water. Do not allow the surface of the electrolyte to get below the top of the plates; keep it above by adding sufficient suitable water to each cell as often as necessary to keep it just below the filling tubes in sealed rubber jar batteries and ¾ in. above the top of plates in glass jar and wood lead lined tank batteries.

It will never be necessary to add new electrolyte unless some should actually be lost due to spillage or similar causes.

Battery Water

Only suitable water should be used for replacing evaporation. Distilled water is suitable. Well, spring or river waters are often so. Rain water is usually satisfactory if obtained on a clean slate or shingle roof in the open country, but care should be taken to allow the rain to flush the roof before catching the water.

If in doubt as to whether the water is suitable, the battery manufacturer will analyze samples if submitted for test. At least a quart sample should be submitted.

Never transport or store water in any metallic vessel (lead excepted) and keep receptacle clean and covered to keep out impurities. Glass, earthenware, rubber or wooden receptacles that have not been used for any other purpose are satisfactory.

Pilot Cell

Select a cell as a pilot cell and use it to check the amount of charge and discharge given in the entire battery during its operation. This cell should be readily accessible. Mark it so that it will be easy to find and see at any time.

Discharge Rates

High discharge rates (amperes) are often confused with overdischarge (too many ampere hours taken out). A battery may, without injury to the plates, be discharged at any rate of current that it will deliver. Maximum permissible rate of discharge is limited only by the size of wiring used, by the capacity of the motor or other apparatus to which the battery is connected, by the current carrying capacity of the cell terminals and connectors and not by the plates themselves.

Effect of Discharge Rate on Discharge Capacity

The ampere hours which may be obtained from a battery are greater for a long low rate or intermittent rate discharge than for a short high rate discharge. This is because the voltage drops faster the higher the rate.

Any particular battery is given a so called "normal rate" which is the capacity obtainable under certain working conditions. This so-called "normal rating," however, is not the capacity obtainable under all conditions.

Discharge Limits

In an emergency, little if any, permanent harm will result if the battery is discharged to the full amount that it will give (provided that it is immediately recharged) but over-discharging as a constant practice will soon result in permanent damage.

The specific gravity of the electrolyte falls on discharge and is therefore an indication of the amount of discharge. The difference between the full charge and discharge values of the gravity depends upon the type of cell and can be obtained from the manufacturers.

Except in an emergency, the drop in specific gravity should not exceed the number of points specified by the manufacturer.

When to Charge

Charge the battery frequently enough to keep the specific gravity of the electrolyte from falling below the discharge limits given by the manufacturer.

How to Charge

Direct current only must be used; never alternating. The positive terminal of the battery must connect with the positive of charging circuit and the negative of battery with negative of charging circuit. If connected reversed, serious injury will result.

Battery positive terminal is marked P or + or painted red. Negative is marked N or — or is painted black.

When connecting a cell to another in series with it, the positive of one must connect with the negative of the next.

Ventilate the battery room or compartment when charging in order to dispose of gas generated by battery. Never bring a flame or spark such as a candle, lantern or lighted cigar or pipe near the battery when charging or shortly after. On sealed in cells, keep the vent plugs in the cells. Do not remove them during charge except to take specific gravity or temperature readings.

Charge Rates and Length of Charge

The lead acid type battery may be charged at any rate in amperes that will not produce immediate gassing or bubbling of the electrolyte, nor a cell temperature in excess of 110 degrees Fahrenheit or 43 degrees Centigrade. As soon as gassing starts or before if the temperature reaches above limit, the rates should always be reduced and the charge should be completed at rates not higher than specified by the manufacturers for the particular type of cell in question. If charging at constant current is more convenient, the entire charge may be given at the rate specified by the manufacturer.

The best method of charging a battery will depend on the number of cells in the battery, the time available for charging and the voltage and capacity of the charging apparatus. It is recommended that the battery manufacturer be consulted in this matter for the particular type of battery under consideration.

Floating

If the system is designed to automatically keep the battery fully charged, its operation should be checked periodically until it is

certain that the system gives neither too much nor too little charge. With proper adjustment the specific gravity of the pilot cell will remain practically constant if level of electrolyte is kept the same height and the cells will not be gassing. If the cells gas continually, the battery is receiving too much charge. If the gravity continues to drop the battery is not receiving enough charge.

Equalizing Charges

Batteries which are continually floated require no regular equalizing charge. For other methods of operation it is very important to give the battery an equalizing charge regularly.

The equalizing charge is merely a continuation of the regular charge, until all the cells gas freely and the specific gravity of the pilot cell and the voltage of the battery have shown no further increase over a period, the length of the period depending on the type of the battery.

Specific Gravity of Electrolyte

The specific gravity of the electrolyte should, with the cells fully charged, be between the values given by the manufacturer for the particular type of cell under consideration. Unless electrolyte is actually lost, through spilling or leaking, it will not require adjusting during the life of the battery. If, however, electrolyte is spilled, it should be replaced with electrolyte of about the same specific gravity as in the surrounding cells. It will never be necessary to add new electrolyte except in connection with replacing actual loss of electrolyte.

Before adjusting low gravity, first make sure charging will not raise gravity and it is always well to consult manufacturer regarding this point. Never make a gravity adjustment on a cell which does not gas on charge.

Readings

To facilitate following the operation of the battery, it is advisable to record at intervals the specific gravity of each cell.

Impurities

Impurities in the electrolyte will cause a cell to work irregularly. Should it be known that any impurity has gotten into a cell, it should be removed at once. In case removal is delayed and any considerable amount of foreign matter becomes dissolved in the electrolyte, this solution should be replaced with new immediately. Thoroughly flush the cell with water before putting in the new electrolyte. If in doubt as to whether the electrolyte contains impurities a pint sample should be submitted to battery manufacturer for test.

Sediment

The sediment which collects beneath the plates need cause no alarm unless it deposits too rapidly in which case there is something wrong with the way the battery is operated. In a new battery there is always a thin layer at the start. As the battery wears, the sediment becomes higher, but on batteries which are floated the plates usually wear out before the sediment space is filled.

Low Temperature

The capacity of any lead acid battery is temporarily reduced during periods of low temperature but there is no danger of freezing if care is taken when replacing evaporation to add the water just before charging so that it will be thoroughly mixed with the electrolyte by the gassing.

Indications of Trouble

The chief indications of trouble in a cell are

(a) Falling off in gravity or voltage relative to the rest of the cells.

(b) Lack of gassing on equalizing charge.

(c) Color of plates markedly lighter or darker than the surrounding cells.

If any of these symptoms are noted, steps should be taken to eliminate the trouble. If a battery seems to be in trouble the first thing to do is to give it an equalizing charge. Then take a gravity reading of each cell. If all the cells gas evenly on the equalizing charge and the gravity of all of them goes above the value specified by the battery manufacturer, most likely all the battery needed was the charge. Otherwise record all gravities less than the values specified by the manufacturer, resume charge and continue until there is no increase in the gravity of the electrolyte. Then make a gravity adjustment on those which are still below the specified value and which are gassing. If a cell will not gas on above charging, investigate for impurities or inspect it for short circuits.

The above instructions in general cover the different types of lead acid storage batteries which may be used by railroads. Special instructions covering each of the above types of battery in detail as regards their installation and care, are furnished by the battery manufacturers and it is recommended that these complete detailed instructions be obtained whenever possible.

The installation of wood lead lined tank batteries is a special proposition and can be best handled by men skilled in this work and questions covering the installation of this type of battery should always be taken up with the manufacturers.

This is also the case with the operation of large standby batteries for emergency as the instructions covering their care and operation depend largely on local conditions.

THE NICKEL IRON STORAGE BATTERY

General Description

The nickel iron storage battery differs materially from all other types in theory and characteristics in that it has an alkaline instead of an acid electrolyte and nickel hydrate and iron oxide for active materials instead of lead peroxide and spongy lead. The absence of acid permits the elements to be contained in a steel can instead of a rubber jar or lead lining.

The positive plate is composed of perforated nickel plated steel tubes each reenforced by equidistantly spaced steel rings and filled with over 600 alternate layers of nickel hydrate and pure metallic nickel flake. They are mounted in a nickel plated steel grid.

Rectangular pockets of perforated nickel plated steel containing iron oxide secured to a nickel plated steel grid compose the negative plate.

The electrolyte is a 21 percent solution of potassium hydrate to which is added a small amount of lithium hydroxide. The normal specific gravity, which does not change over a long period, is 1.210 at 60° F.

The alternate positive and negative plates are insulated from each other by vertical hard rubber pins or rods equidistantly placed. Molded hard rubber "Ladders" secure the plates at their edges and insulate the whole from the containing can. A sheet of hard rubber is placed between the end negative and can. Small projections at the lower end of these side insulators support the plates at the bottom holding them about ½ in. from the container bottom.

The containing can is of nickel plated steel all seams being oxygen acetylene welded. After the elements have been placed in the can the top is welded on. The poles are insulated from the can and the mechanical joint made gas and liquid tight by special stuffing boxes.

The top of the can supports a combination filling aperture and gas valve.

The poles are tapered to fit the terminal lugs and are brought into intimate contact with same by setting up on the nuts on top of poles.

The cells are assembled in wooden trays each cell being supported by steel bosses welded to the sides of the cell. These bosses fit into recessed hard rubber buttons in the tray slats. This supports the cell firmly in place and thoroughly insulates it, thus eliminating the possibility of grounds.

Starting with iron oxide in the negative, green nickel hydrate in the positive and potassium hydrate in solution the first charging of a cell reduces the iron oxide to metallic iron while converting the nickel hydrate to a high oxide, black in color. On discharge, the metallic iron goes back to iron oxide and the high nickel oxide goes to a lower oxide but not to its orginal form of green nickel hydrate. On every cycle thereafter, the negative charges to metallic iron and discharges to iron oxide while the positive charges to a high nickel oxide. The eventual result of charging, therefore, is merely a transference of oxygen from the iron to the nickel electrode and that of discharging is a transference back again. The action is entirely reversible.

Inspection on Receipt

Upon receipt of the battery, inspect each cell for solution height, as explained in these instructions.

Electrolyte has been spilled if the tubes are visible above the

surface of the liquid. The loss must be replaced, preferable with the proper electrolyte recommended by manufacturer.

When the level of solution is only a small amount below the proper height, fill with pure distilled water and in the future use pure distilled water for replenishing evaporation.

Connections

To avoid unnecessary electrical losses all electrical connections must be tight. To obtain this it is necessary to see that all contact surfaces between the poles and lugs are clean and make good contact. Remove any vaseline, grease or dirt that may stick to the tapered surfaces of the poles or the inside of the lugs before connecting. If necessary, use 00 sandpaper or 00 emery cloth for this purpose. Never use a file or anything to harm the contact surfaces.

A loose or dirty contact on a cell pole will cause excessive heating and may be detected by feeling the connectors after the current has been passing for some time.

To disconnect, first take nut off of each pole. A disconnecting jack is furnished by manufacturer. This jack is designed to straddle the pole and engage the lug, and then pulls the lug loose by means of a screw, after which it may be taken off by hand.

Battery Compartments

Batteries installed in compartments should be held securely. The compartments should be lined with wood and constructed to afford ample ventilation, good drainage and ease in cleaning.

Except in Railway Car Lighting service, where compartments are made according to M.C.B. standards, and in services such as Ignition and Lighting where the batteries are assembled in steel boxes which permit of all advantages as outlined in this section, slots one inch wide and the full length of each tray are recommended in the bottom of battery compartments directly under each tray when bottomless trays are used, and between trays when trays with bottoms are used. Openings should be provided in the sides of compartments, above the highest point of the battery. The total area of these openings should be slightly greater than the total area of the bottom openings. Locate the openings to keep out as much dirt and water as possible. If battery is used out of doors, those openings should be closed during cold winter weather.

If battery is to be mounted beneath steel channels, etc., or other metal structure, at least one-half inch clearance should be allowed over Height Over-all (Filler Cap Open) otherwise allow at least three-quarter inch clearance over Height Over-all (Filler Cap Closed).

For stationary batteries not installed in a compartment it is recommended that batteries be placed in a dry, well ventilated room on a rack or shelf, with about one inch space around each tray, and with at least six or eight inches of head room, to permit ample circulation of air and sufficient space for proper cleaning and filling of the cells.

If batteries are installed in a compartment that formerly carried lead acid batteries, compartment should be thoroughly washed out with strong soda solution to neutralize acid, then painted and new floor applied.

Constant Current Charging

In this method of charging, a direct current source must be provided, with an available voltage of at least 1.85 times the number of cells in series and a capacity of at least the normal rate of the type cells to be charged. Provision should, of course, be made to take care of maximum requirements, but the line voltage should not be so high that excessive loss of power in resistance will be had.

In the strict interpretation of the term "constant current charging" the supply is usually of practically constant voltage and, therefore, variable resistance must be provided and periodically manually adjusted so that the normal rate will be maintained. This is because of the fact that any storage cell, while charging, increases in internal resistance and, therefore, the external resistance must be cut down to maintain the initial current value from a given voltage source. At each adjustment the current should be set a few amperes high so that at the next adjustment the rate will not be much below normal. In this way the average current during the charge will be normal.

The proper length of charge may be determined by the amount of the previous discharge, preferably by the use of an ampere hour meter set for between 15 percent and 25 percent excess charge, depending on service conditions, or by simply charging until a maximum cell or battery voltage has been reached and maintained for at least 15 minutes. This maximum voltage value will vary between about 1.80 and 1.90 volts per cell, depending on the temperature, etc., but this is of no consequence because the idea is to reach and reasonably maintain any maximum voltage.

For all ordinary conditions batteries should be charged for the proper length of time at the rate specified by the manufacturer for the type cell being charged. Charging in this way will give satisfactory results regardless of the discharge rate required or the type of service for which batteries are used. Where the rates of discharge will frequently be much higher than normal it is essential that the charging rate be normal.

It is not necessary to take specific gravity reading during charge, as the electrolyte does not change appreciably.

If a battery has been discharged to the final useful point of 1.0 to 0.9 volt per cell it should be recharged at its normal rate for the proper number of hours as given by the manufacturer. If battery has been one-half discharged, then charge for one-half the time at the normal rate, etc., making check readings to determine when maximum voltage has been reached.

Where the discharge requirements are such that a low constant rate is used or where an intermittent rate of such value that for a given time period a low average rate will be had, then a charge rate of less than normal may be used providing that this charge rate is approximately 120 per cent of the constant or average discharge rate. The term "low discharge rate" is to be construed to mean a constant or average rate of less than 80 per cent of normal.

When charging at low rates it must be thoroughly understood that the required ampere hour input must be put in and that, therefore, the time periods of charge must be correspondingly increased over that necessary to fully charge a cell at normal rate.

Modified Constant Potential Charging

Any properly designed constant current set up may be used with complete success for modified constant potential charging where the source capacity is sufficient and where the current carrying parts are designed for about 100 per cent overload. Best practice indicates a voltage necessary of 1.84 times the number of cells in series applied across the battery and a series resistance of the value supplied by manufacturer. All batteries must have the same number of cells in each, although they may be of different size in different batteries. Variation of internal resistance between batteries can be taken care of by small adjustments in the variable resistance when starting charge.

With the above closely followed out, a battery that starts charge in a discharged state of about the final useful voltage point of 1.0 or 0.9 volt per cell the initial current will be about 165 per cent of normal and the final current will be about 65 per cent of normal, averaging about 100 per cent of normal during the proper time period.

Boost Charging

In an emergency, when time for a normal charge is not available, charging may be done at any higher rates than normal, provided there is no frothing and the temperature does not rise about 115 deg. F. in the warmest part of the battery.

External Cleaning

Nickel Iron cells require only external cleaning. The cells, trays and battery compartment must be kept dry, and care must be taken that dirt and other foreign substances do not collect at the bottom or between the cells.

The tops of the cells should be given a light coat of liquid vaseline. This material should be applied to the cover of the cell and sparingly to the outside of the filling aperture, care being taken not to get any great quantity on lid hinge. Liquid vaseline may be applied best with a small paint brush, care being taken not to get any on the inside of lugs or on cell poles.

Thorough cleaning cannot be done without removing the battery from the compartment. A wet steam jet, or even an air blast will be found most satisfactory for the purpose, but must not be used on cells while in the compartments. We have found that a pressure of 70 pounds with a one (1) inch rubber steam hose about ten (10) feet long into which has

been inserted a piece of iron pipe about twelve (12) inches long with an orifice 1/8 inch in diameter will give wet steam with a velocity to clean the battery satisfactorily. (This orifice can be made by plugging one end of an iron pipe and drilling out with a 1/8 inch drill). When removing incrustations from the tops of cells, do not allow them to fall between or into the cells. Before reassembling, make sure that all poles, connectors and jumper lugs are clean. Also cells, trays and compartments must be dry before replacing battery.

Dirt and dampness are likely to cause current leakage which may result in serious injury to the cells.

Occasionally, cells and trays after being cleaned should be recoated with an alkali-proof insulating paint put up by the manufacturer.

The cells should be thoroughly cleaned of all grease, dirt, dried salts and paint blisters or flakes and be perfectly free from all moisture. Painting may be done with a brush or, if the quantity is large by dipping.

Test for Solution Height

Test for height of solution before placing battery on charge. Do not test for solution height while battery is charging; the gassing during charge creates a false level.

A reasonably heavy walled glass tube about 8 inches long and of not less than 3/16 inch inside diameter with ends cut straight and fused enough to round the edges, may be used as illustrated to find level of electrolyte above plate tops. A short length of tightly fitting rubber tube forced over one end and projecting about 1/8 inch will prove a very good finger grip.

Insert the tube until the tops of the plates are touched; close the upper end with the finger, and withdraw the tube. The height of the liquid in the tube should be as specified by the manufacturer.

Watering or Flushing

For replenishing solution Nickel Iron cells during operation use only pure distilled water which has been kept in a closed container.

An electric filler will greatly simplify this important maintenance duty.

Specific Gravity

The only time it is necessary to obtain specific gravity readings is to determine when a change of electrolyte would be advantageous.

The specific gravity should be taken with a standard hydrometer when the electrolyte is at the proper height after a complete charge. It is best to allow the cells to stand for a short time after the completion of the charge to allow free bubbles of gas to dissipate before taking readings. Corrections for temperature should be made if temperature is very high by adding .0025 for each ten degrees above 60 deg. F. or subtracting .0025 for every ten degrees below 60 deg. F.

After taking a specific gravity reading return the solution to same cell taken from. Otherwise the gravity of the solution in the cell to which it is added will be increased and the gravity of the solution in the cell it is taken from will be decreased due to the addition of water made necessary.

Solution Renewal

Throughout the total useful life of the cell the electrolyte gradually weakens and may need renewal from one to two times, depending on the severity of service and in some cases where maintenance and operation have been poor, or where contamination has been allowed by the use of impure water, etc., a third time might be necessary.

The low limit specific gravity beyond which it is inadvisable to run an electrolyte is 1.160 with conditions identical with above.

Do not use any other solution than the electrolyte specified by the manufacturer.

Do not pour out old solution until you have received new and are ready to use it. Never allow cells to stand empty.

State type and number of cells when ordering electrolyte for renewal in Nickel Iron Batteries.

When ready to renew solution first completely discharge the battery at normal rate to zero and short circuit for one or more hours. This is to protect the elements. Then pour out half the solution, shake the cell vigorously and then empty. It will be found necessary, except for the very small types, to remove the cells from the trays and to treat each separately. Do not rinse cells with water, use only the old solution.

Immediately after emptying each cell pour in new solution. Do not allow to stand empty. Fill to exactly the proper height. For this purpose use a clean glass or enamelware funnel. A plain iron funnel can be used if it has no soldered seams, but do not by any means use one of tinned or galvanized iron. A clean rubber tube may be used to siphon the solution directly from the container to the cell. If the tube is new it should be thoroughly soaked in electrolyte for a couple of hours or filled with electrolyte and allowed to stand a couple of hours in such a position as to retain the solution. This is to thoroughly remove any impurities on the rubber. Fill to exactly the proper height, for if cells are filled too full when renewing the solution and allowed to remain that way the specific gravity of the electrolyte will be too high when the level of the solution returns to proper height. This condition may lead to serious results and can be easily avoided by reasonable care.

Overcharging

Overcharging is to be interpreted as charging a battery at the normal rate for periods in excess of the specified "hours normal charge." The length of the overcharge depends upon the type of battery and may be obtained from the manufacturer.

Overcharging in conjunction with proper discharges is used to compensate either for lack of work of battery or after change of solution. In those cases where batteries have become sluggish due to lack of work, such as where batteries are seldom totally discharged in regular service, the battery should be periodically completely discharged to zero at normal rate and then short circuited for one or two hours. Follow with a regular overcharge.

With new Nickel Iron Batteries better capacities will result if they are given plenty of work. It is therefore, advisable to give new batteries additional work every two weeks for the first two months and every two months thereafter for six months. This should consist of a complete discharge to zero at normal rate with a short circuit of at least two hours followed by an overcharge.

When a Nickel Iron Battery does not give satisfactory capacity on discharge at rates several times normal it is considered sluggish. This sluggishness or low capacity may result from persistent low rate discharging, frequent low rate charging, long stands, seldom discharging completely, or from weak solution. With the exception of the last named the primary cause is lack of work. Nickel Iron Batteries thrive on work, therefore, the proper procedure is to completely discharge the battery at normal rate to zero and then short circuit for two hours. Follow this by an overcharge. If the condition is rather pronounced the cycle should be repeated. In the worst cases results can usually be obtained by several repetitions of the above. Ordinarily, this method will restore underworked batteries.

An overcharge should be given battery after solution renewal.

Rejuvenation Treatment

Should the specific gravity be above 1.160 and at the same time sluggishness and loss of capacity be evident, do not immediately renew the electrolyte until it is found that an electrolyte sample sent to the factory shows a prohibitive accumulation of impurities and until the following treatment fails to produce marked improvement.

(a) Discharge at normal rate to zero voltage. It is of prime importance that the rate be kept at normal throughout.

(b) Then short circuit the battery in groups of not more than about 5 cells each for at least 2 hours.

(c) Charge at normal rate for the number of hours specified by manufacturer for the particular battery.

(d) Discharge at normal rate to approximately 1.0 to 0.9 volt per cell.

(e) Discharge at normal rate to approximately 1.0 to 0.9 volt per cell.

If the cells do not respond noticeably to this treatment there is probably very marked contamination of the electrolyte, and the result of the analysis of representative sample sent to the manufacturer, will show this. Therefore, regardless of the specific gravity the electrolyte should be replaced as follows:—

1. When previous electrolyte has reached approximately the low limit of 1.160 the new solution should be obtained as recommended by manufacturer.

2. When previous electrolyte is appreciably above the low limit of 1.160 the new solution should be obtained as recommended by manufacturer.

Capacity Test

All Nickel Iron Batteries should deliver rated capacity when discharging at their normal rate down to 1.0 V.P.C. average.

A capacity test should be made only after a preceding discharge at normal rate down to 1 V.P.C. and after a normal length charge.

The test discharge should be begun as soon as practical after the completion of charge. The battery should be discharged at its normal rate down to 1 V.P.C. average, being sure to keep the rate constant.

The capacity delivered by the battery may be determined by multiplying the normal rate in amperes by the number of hours the battery discharges before its voltage reaches 1 V.P.C. (average.)

Laying Up the Battery

If battery is to be laid up for any length of time be sure that the plates are covered to the proper height by solution or electrolyte.

The battery should be stored in a dry place. Do not leave it in a damp place as damage to the containers may result from electrolysis.

Never let the battery stand unfilled.

Placing the Battery Back Into Commission

When putting the battery back into commission go over each cell, see that all poles and connections are in good condition as for a new cell. See that the plates are properly covered with electrolyte and then charged as here instructed.

First, if not already discharged, discharge cells to zero at normal rate and short circuit. Follow by an overcharge at normal rate and then discharge at normal rate. Then charge at normal rate for normal hours of charge. If the battery shows signs of sluggishness repeat the overcharge and carry the discharge down to zero until cells are fully active—then give regular charge.

Analysis Samples of Water and Electrolyte

Cell samples should be sent to manufacturer.

In submitting samples of water or electrolyte for chemical analysis the following should be carefully noted:

1. Not less than 1 pint (16 fluid ounces or 473 cubic centimeters) of water or electrolyte is required to make a complete and satisfactory analysis.

2. Before taking samples of electrolyte from cells there are two points which must be rigidly adhered to and corrected if not right:—

(a) Solution in cell must be at the normal level as given by manufacturer's instructions.

(b) Solution in cell must be thoroughly mixed, preferably by charging.

Both of these restrictions are fundamentally important, and if not followed, erroneous analysis results will be had. In the case of (a) a low or high level of solution will show, respectively, high or low densities and impurity amounts not in accord with real conditions obtaining in cell. In the case of (b) a solution not thoroughly mixed will show low density and impurity amounts due to dilution on account of the fact that the distilled water, added to raise solution to the normal level, forms a more or less distinct strata until mixed because of its lower specific gravity than the main body of solution.

3. Samples should be placed in absolutely clean glass bottles.

4. Bottles should be sealed with absolutely clean stoppers—these should be washed similarly and at the same time as the bottles, regardless of whether they are old or absolutely new. This is particularly necessary in the case of Rubber Stoppers on account of the zinc chloride or the sulphur coating used for protecting the mass until put into use.

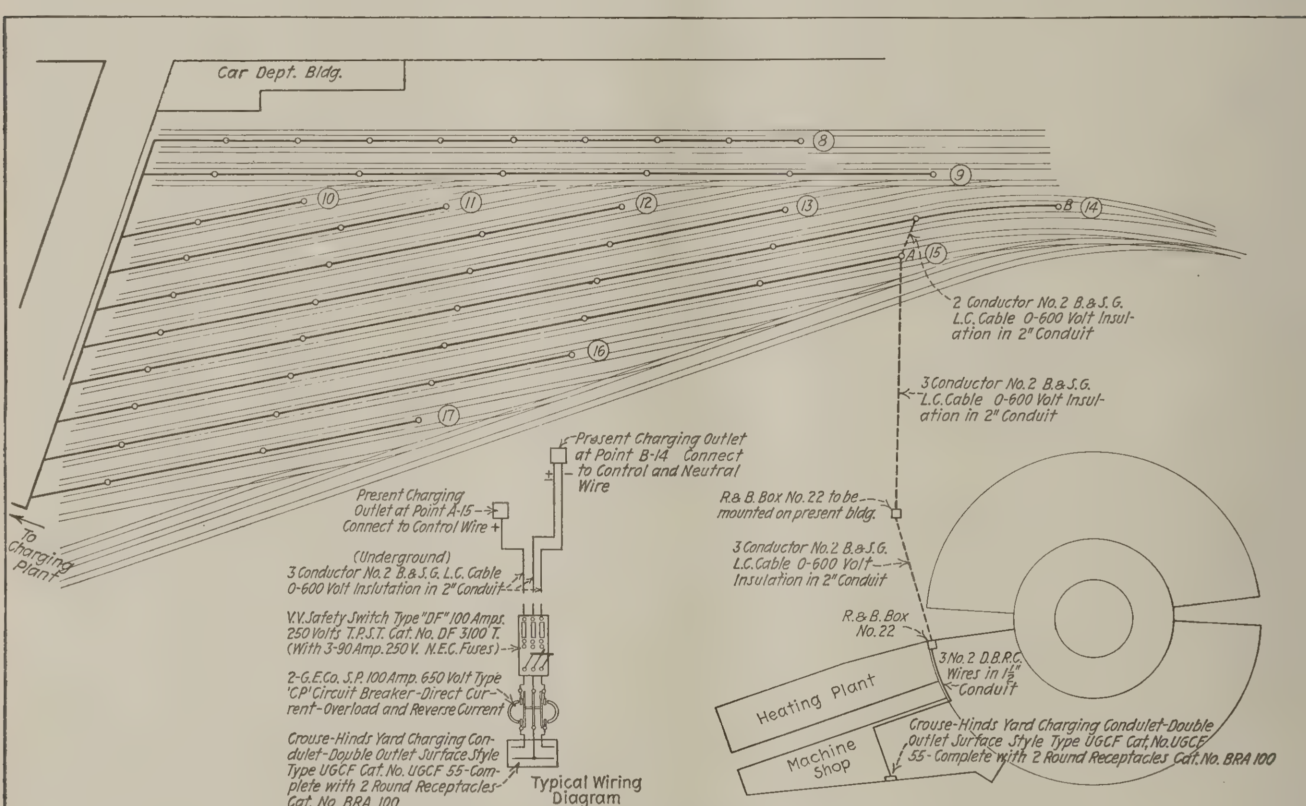
Bottles containing water samples may be sealed either with cork or rubber stoppers.

Bottles containing electrolyte samples must absolutely not be sealed with cork stoppers—rubber stoppers must be used.

5. In addition to sealing bottles with proper stoppers, the latter should be tied in place with cord or with friction tape so as to insure against leakage in transit.

6. Pack sample bottles carefully with enough absorbent, cushioning material to entirely take up the contents of bottles if there should be a leakage due to breakage or loosened stoppers. Use wooden boxes preferably, although corrugated cardboard cases or wrapping paper and equal amounts of absorbent cushioning material are used.

7. Full data covering each sample should be supplied at the time the samples are sent in, preferably in the form of a letter sent separately.



Sketch Showing Typical Arrangement of Charging Outlets

Each sample bottle should bear identification numbers and customer's name and address so that data shown in letter may be applied without confusion. The case should bear details shown on sample bottles.

Complete data as to troubles experienced, etc., is highly important, as much time is lost by the chemist and other responsible parties in guessing and following false leads.

Data required may be summarized as follows:

(a) Source of sample.
(b) Object of analysis.
(c) Actual troubles experienced.

Cautions

1. Never put lead battery acid into nickel iron battery or use utensils that have been used with acid; you may ruin the battery.
2. Never bring a lighted match or other open flame near a battery.
3. Never lay a tool or any piece of metal on a battery.
4. Always keep the filler caps closed except when necessary to have them open for filling as provided in these instructions.
5. Keep batteries clean and dry externally.

The type of each cell is plainly stamped on the cell cover; also a cell serial number.

Voltage Required for Charging at Normal Rate

Minimum Line Voltage Impressed at Battery Terminals

5	cells require	9.25	volts D. C.
10	" "	18.5	" " "
20	" "	37.0	" " "
24	" "	44.4	" " "
28	" "	51.8	" " "
32	" "	59.2	" " "
36	" "	66.6	" " "
40	" "	74.0	" " "
44	" "	81.4	" " "
48	" "	88.8	" " "
52	" "	96.2	" " "
56	" "	103.6	" " "
60	" "	111.0	" " "
64	" "	118.4	" " "
68	" "	125.8	" " "
72	" "	133.2	" " "
76	" "	140.6	" " "
80	" "	148.0	" " "

A typical plan for charging tractor and car lighting batteries is printed herewith. In the buildings housing the batteries and charging equipment no special precautions have been observed, except to thoroughly ventilate with natural ventilators placed in the ceilings of the larger plants. Under very exceptional conditions, it may be necessary to use motor driven fans to force air in and out of rooms where tractor batteries are charged.

Maintenance.

First.—In the maintenance of electrical equipment, it is recommended that thorough systematic, periodic inspection be made and any improper or irregular condition found, correction shall be made immediately.

Second.—Equipment shall be kept thoroughly dry and clean.

Third.—When each inspection is made, it should include the supports sustaining the equipment which should be kept secure and rigid. All power transmitting devices such as belts, gears, etc., should be included in this inspection.

Fourth.—The inspector should see that all circuits are properly protected by automatic circuit opening devices properly set and operative.

Fifth.—It is suggested that there must be at least two employees present when repairs are being made to high tension apparatus or lines.

Sixth.—All motors operating turntables, elevators, transfer tables, line shafts or other machinery where a repairman is likely to be working concealed from view of the control station, a safety switch must be provided so that workman can lock it open before such work is started.

Seventh.—Before any work on cranes or their runways, the crane operator must be notified by the workman. A form might be provided for that purpose or simply a written note. The operator should sign the form which will be kept by the workman until repairs are made.

Eighth.—For the safety of repairmen and others the following suggestions are furnished:

Don't work on live circuits except when absolutely necessary, then take proper precautions.

Don't work on high tension apparatus until you are sure it is disconnected from the line and grounded.

Don't lay tools where they are liable to fall and cause damage or accident.

Don't feel a circuit to see whether it is alive or not. Use a meter or test lamp instead.

Don't wipe, oil or adjust a machine while in motion.

RESUSCITATION

It is recommended that instruction in the Schaefer or "Prone Pressure" Method of Artificial Respiration be given to employees monthly, or at least three times a year, and that periodic examinations be conducted to ascertain their knowledge of company rules and regulations in respect to safety precautions. Men engaged in test work of any description should be thoroughly familiar with the Schaefer or "Prone Pressure" Method of Artificial Respiration and all company rules and regulations pertaining to safety.

(The rules printed below for Resuscitation from Electrical Shock by the Prone Pressure Method are reprinted by courtesy of the National Electric Light Association, 29 West 39th street, New York, N. Y.)

TREATMENT FOR ELECTRICAL SHOCK

An accidental electrical shock usually does not kill at once, but may only stun the victim and for a while stop the breathing.

The shock is not likely to be immediately fatal, because:

(a) The conductors may make only a brief and imperfect contact with the body.

(b) The skin, unless it is damp with perspiration or wet, offers some resistance to the current.

The life of the victim depends upon the prompt and continued use of artificial respiration. The reasons for this are:

(a) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(b) If the body is not thus repeatedly supplied with air, suffocation occurs.

(c) Persons whose breathing has been stopped by electrical shock have been reported restored after artificial respiration has been continued for approximately four hours, and the treatment should be continuously applied until rigor mortis (stiffening of the body due to death) sets in.

The Schaefer, or "prone pressure" method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(a) It is immediately available.

(b) Easy performance; no apparatus and little muscular exertion required.

(c) Larger ventilation of the lungs than by the supine method.

(d) Simplicity, the operator makes no complex motions and readily learns the method.

(e) No trouble from the tongue falling back into the air passage. The first impulse is expiration and any foreign substance in the mouth or air passage will likely be expelled.

(f) No risk of injury to the liver or ribs if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

INSTRUCTIONS FOR RESUSCITATION

Follow these Instructions Even if Victim Appears Dead

I.—Free the Victim from the Circuit Immediately

1. Quickly release the victim from the current, being very careful to avoid receiving a shock. Use any dry non-conductor (rubber gloves, clothing, wood, rope, etc.) to move either the victim or the conductor. Beware of using metal or any moist material. If both of the victim's hands are grasping live conductors endeavor to free them one at a time. If necessary shut off current.

Begin at once to get the subject to breathe (resuscitation) for a moment of delay is serious. Use "Prone Pressure Method" for four (4) hours if necessary, or until a doctor has advised that rigor mortis has set in.

Observe the Following Precautions

(a) The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous. If this is impossible, use rubber gloves, a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the conductor, so as to break the electrical contact.

(b) If the bare skin of the victim must be touched by your hands, be sure to cover them with rubber gloves, mackintosh,

rubber sheeting or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only *one* hand.

If the man receives a shock while on a pole, first see that his belt is secure around the pole, if possible above cross-arm so victim will not fall, then break the current. Pass a hand-line under his arms, preferably through his body belt, securely knot it, and pass the end of the line over the first cross-arm above the victim. If you are alone, pass the line once around this cross-arm. If you are not alone, drop the line to those at the base of the pole. As soon as the rope is taut, free the victim's safety belt and spurs and descend the pole, guiding the victim. When the victim is about three feet from the ground, lower rapidly so that the victim's feet hit the ground hard.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an axe or a hatchet with a dry wooden handle, turning your face away to protect it from electrical flash.

II.—Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.) If the mouth is tight shut, pay no attention to the above-mentioned instructions until later, but immediately begin resuscitation. The patient will breathe through his nose and after resuscitation has been carried on a short time, the jaws will probably relax, and any foreign substance in the mouth can then be removed. Do not stop to loosen the patient's clothing; every *moment of delay is serious.*

2. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow with the face resting on hand or forearm so that the nose and mouth are free for breathing. (See Fig. 1.)

Fig. 1

3. Kneel, straddling the patient's hips, with the knees just below the patient's hip bones or opening of pants pockets. Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, the thumb alongside of the fingers, the tips of the fingers just out of sight. (See Fig. 1.)

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject. (See Fig. 2.) This operation, which should take from two or three seconds, *must not be violent*—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs, the diaphragm is kept in natural motion, other organs are massaged and the circulation of the blood accelerated.

5. Now *immediately* swing backward so as to completely remove the pressure, thus returning to the position shown in Fig. 3. Through their elasticity, the chest walls expand, and the pressure being removed the diaphragm descends, and the lungs are thus supplied with fresh air.

6. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing, the proper rate may be determined by counting—swinging forward with each expiration and back with each inspiration.

7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing about the patients' neck, chest or waist. (KEEP THE PATIENT WARM.) Place ammonia near the nose, determining safe distance by first trying how near it may be held to your own. Then the assistant should hit the patient's shoe heels about twenty (20) times with a stick, and repeat this operation about every five minutes, until breathing commences. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. Continue artificial respiration without interruption (if necessary for four hours) until natural breathing is restored. Cases are on record of success after three and one-half hours of effort.

Fig. 2

The ordinary tests for death are not conclusive in cases of electric shock and doctors must be so advised by YOU, if necessary.

9. When the patient revives, he should be kept prone (lying down)—and not allowed to get up or be raised under any consideration unless on the advice of a doctor. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of hot ginger tea or coffee.

The patient should then have any other injuries attended to and be kept warm, being placed in the most comfortable position.

10. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition, and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, he should be kept in a prone position and placed upon a hard surface (door or shutter) or on the floor of a conveyance, resuscitation being carried on during the time that he is being moved.

Fig. 3

11. A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently, the patient, after a temporary recovery of respiration, stops breathing

again. The patient must be watched, and if normal breathing stops, artificial respiration should be resumed at once.

III.—Send for a Doctor

If other persons are present when an accident occurs, send one of them for a doctor without a moment's delay. If alone with the patient, do not neglect the immediate and continued resuscitation of the patient for at least one hour before calling a doctor to assist in further resuscitation efforts.

A published, up-to-date list of doctors posted by the company is recommended.

IV.—First Care of Burns

When natural respiration has been restored, burns, if serious, should be immediately attended to while waiting for the doctor to arrive.

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface should be saturated with picric acid (0.5 per cent.). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water, or it may be protected with vaseline, carron oil, olive oil, castor oil or machine oil, if clean. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchief, or other soft cloth, held tightly in place by a bandage.

The same covering should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.

The prone-pressure method of artificial respiration is equally applicable to resuscitation from electrical shock as well as all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes, or to other causes.

Respectfully Submitted,
COMMITTEE ON SAFE
INSTALLATION AND MAINTENANCE
OF ELECTRICAL EQUIPMENT.

Report of Committee on Illumination

Although Much Information Has Been Gathered Committee Feels That Definite Standard for Flood Lighting Cannot Be Established At This Time

Committee:—

L. S. Billau, chairman, assistant electrical engineer, Baltimore and Ohio; J. E. Gardner, electrical engineer, Chicago, Burlington and Quincy; G. T. Johnson, assistant electrical engineer, New York, New Haven and Hartford; J. L. Minick, assistant engineer, Pennsylvania System.

TO THE MEMBERS:

Your Committee respectfully submits its report on the following subjects:

1. Revision of Manual.
2. Developments in incandescent lamps for train lighting service.
3. Developments in incandescent lamps for locomotive lighting service.
4. Developments in incandescent lamps for general service and other special uses of interest to railroads.
5. Continuation of the study of flood lighting of railroad yards.

Action Recommended

1. That the changes and the additions to the Manual as covered in subject No. 1 be adopted by the Association.
2. That the report on the developments of train lighting lamps be accepted as information and the subject continued.
3. That the report on the developments of locomotive lighting lamps be accepted as information and the subject continued.
4. That the report on the development of incandescent lamps for general service and for special uses be accepted as information and the subject continued.

Recommendations for Future Work

1. Continue the report on the developments of incandescent lamps of interest to the railroad field, including the tables showing the demand for lamps in the train lighting and locomotive lighting schedules.
2. Continue the study of flood lighting as applying to various outdoor lighting problems in the railroad field.

1. REVISION OF MANUAL

Your Committee recommends the following revisions in the Manual:

1. That the new train lighting lamps as listed in Table 4 be substituted for the lamps now listed in Table 4, paragraph 1, of Section V of the Electric Train Lighting Section.

2. That Section IV of the Electric Headlights and Locomotive Lighting Section be changed as follows:

(a) Substitute for Par. 1 (a) which covers the G-30 bulb lamp. The 250 watt, 32 volt, P-25 bulb concentrated filament lamp is recommended as standard for use in headlights of road engines.

(b) Eliminate present Pa. 1 (b) which covers the P-25 bulb lamp as an alternate standard.

(c) Substitute for Par. 1 (c) which covers the S-17 bulb cab lamp, new Par. 1 (b). The 15 watt, 33 volt, S-14 bulb locomotive cab lamp is recommended as standard for use in cabs, signals, engine number lights and all other outlets than the headlight lamps.

(d) Eliminate present Par. 1 (d) which covers the S-14 bulb lamp as an alternate standard.

3. That Section 6—Yard Lighting of the Lighting Practice Manual be re-written to incorporate the additional information on this subject, eliminating those parts that have been superseded.

2. DEVELOPMENTS IN INCANDESCENT LAMPS FOR TRAIN LIGHTING SERVICE

The most important change in the train lighting schedule has been the placing in commercial production on a large scale the new standard simplified line of lamps in the A inside frosted bulbs. This line of lamps was first introduced to the railroad field at last year's Convention, a complete description of the line with illustrations being given in the 1925 report of this Committee. All of these lamps are of the gas filled construction, except the 15 watt, 64 volt lamp, and are practically equal in efficiency, and in some sizes better, to the corresponding sizes of gas filled lamps in the PS bulb. The new lamps are now available at lower prices than those of the PS bulbs.

It is reported that many of the railroads have already accepted the new line in place of the older types. The demand is more general than indicated by the figures given in Table 2, as this represents the year ending July 1st, during which period the lamps had been on the market only a few months.

One of the questions that has been most frequently raised in connection with these lamps has been to what extent the inside frosting might affect the efficiency of the lamps and the light distribution as obtained with types of lighting units generally used in train lighting service. While the absorption on account of the frosting is low, only about 2 per cent, the actual difference in the light output of the lamps in the 32 volt class is better still, varying from a loss of 1.67 per cent for the 25 watt lamp to a gain of 5.9 per cent for the 100 watt size, this being due to the improved efficiencies of the new line. Realizing the difficulties of securing reliable comparison between the two types of lamps from individual illumination tests made on cars, unless carefully selected and calibrated lamps are used, etc., your Committee had comparative light distribution characteristics curves made, under laboratory conditions, with the three representative types of modern lighting units as employed in the day coach illumination tests as given in Table 2, Section 7, of the Lighting Practice Manual. These light distribution curves and data are shown in Figs. 1, 2 and 3 and Table 1.

It will be noted that the difference in efficiencies is practically negligible with the open reflectors and amounts to only 3 per cent with the enclosing bowl. With the open reflectors and inside frosted lamps there is a slight increase in the downward candle power with a small falling off in the 35°-45° zone. With the better diffusion obtained with the bare inside frosted lamp it is felt that somewhat lighter density opal enclosing glassware can be safely used which would improve the efficiency with a luminaire such as employed in Test C. Therefore, where it is desired to improve the efficiency of light distribution with the enclosing glassware type of unit consideration should be given to selecting somewhat lighter density opal glass than is now generally used.

Table 1—Comparison of Light Distribution Obtained with the Old Type Clear and New Type Inside Frosted Train Lighting Lamps

	Clear lamp	Inside frosted lamp	Per cent difference
A—Test with satin finish prismatic glass reflector, Holophane No. 1,826SF—			
Type of lamp	50 W PS-20	50 W A-21	.....
Total lumens, bare lamp	735	725	—1.36
Total lumens, luminaire	631	623	—1.27
Per cent of bare lamp lumens	86	86	0
B—Test with heavy density opal glass reflector, Sudan No. 18,678—			
Type of lamp	50 W PS-20	50 W A-21	.....
Total lumens, bare lamp	735	725	—1.36
Total lumens, luminaire	552	536	—2.9
Per cent of bare lamp lumens	75	74	—1.0
C—Test with enclosing opal glass bowl, Moonstone No. 51,646—			
Type of lamp	100 W PS-25	100 W A-23	.....
Total lumens, bare lamp	1,690	1,790	+5.9
Total lumens, luminaire	1,083	1,091	+0.74
Per cent of bare lamp lumens	64	61	—3.0

In Table 2 is shown a comparison of the total demand in this country for lamps in the train lighting schedule for the years ending July 1, 1925 and 1926, this corresponding to similar data the Committee has published for the past few years.

In Table 3 is shown the distribution of the demand according to voltage, in which it will be noted that the 32 volt lamps constitute 72.4 per cent of the 30-34 volt range, and 64 volt lamps 62.9 per cent of the 60-65 volt range, and together these two voltages represent 71.4 per cent of the total train lighting requirements. The advantages of confining the demand to a single voltage lamp in each of these classes is obvious. It is recognized, however, with the train lighting systems in service today, that there is of necessity a certain limited demand for lamps above

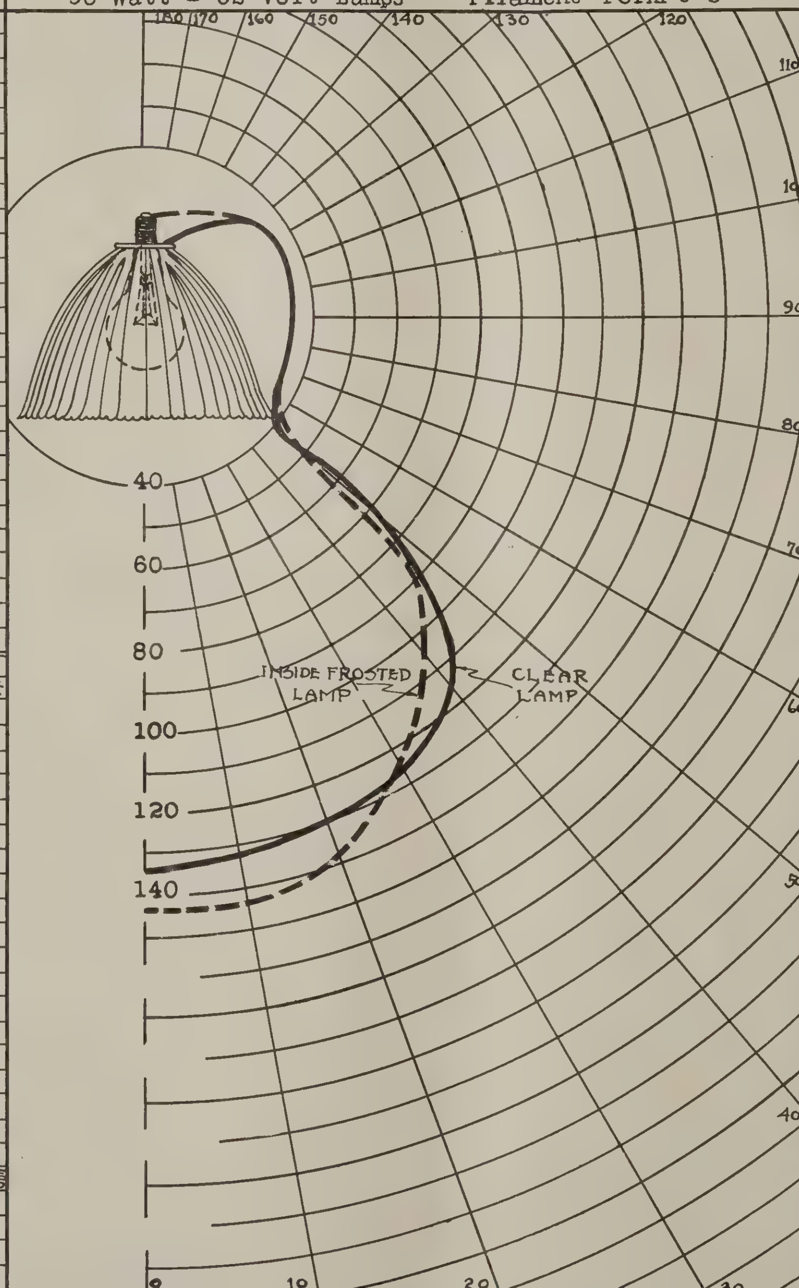
PS-20 Clear Lamp

Apparent Candlepower		
Angle	Bare Lamp	Luminaire
0		134
5		135
15		130
25		129
35		124
45		110
55		39
65		36
75		36
85		36
90		36
MLHCP		67
95		36
105		36
115		37
125		37
135		35
145		28
155		21
165		21
175		21
180		21
MUHCP		33
MSCP	59	50

Zonal Lumens		
Zone	Bare Lamp	Luminaire
0-10		13
10-20		37
20-30		60
30-40		78
40-50		85
50-60		35
60-70		36
70-80		38
80-90		39
90-100		39
100-110		38
110-120		37
120-130		33
130-140		27
140-150		18
150-160		10
160-170		6
170-180		2
Total	735	631

Zone	Lumens	% Total Bare Clear Lamp
0-60	308	42
0-90	421	57
90-180	210	29
0-180	631	86

50 Watt - 32 Volt Lamps Filament Form C-9



A-21 I. F. Lamp

Apparent Candlepower		
Angle	Bare Lamp	Luminaire
0		143
5		143
15		139
25		133
35		115
45		95
55		39
65		36
75		37
85		37
90		37
MLHCP		65
95		38
105		37
115		36
125		36
135		34
145		29
155		24
165		23
175		23
180		23
MUHCP		34
MSCP	58	50

Zonal Lumens		
Zone	Bare Lamp	Luminaire
0-10		14
10-20		39
20-30		62
30-40		72
40-50		73
50-60		35
60-70		36
70-80		39
80-90		40
90-100		42
100-110		39
110-120		36
120-130		32
130-140		26
140-150		18
150-160		11
160-170		7
170-180		3
Total	725	623

Zone	Lumens	% Total Bare Clear Lamp
0-60	295	41
0-90	410	56
90-180	213	30
0-180	623	86

Fig. 1—Distribution Curves With Holophane Reflector No. 18226 SF

TABLE 2—COMPARISON OF DEMAND FOR TRAIN LIGHTING LAMPS, YEARS ENDING JULY 1, 1925 AND 1926

Size in watts	Bulb	Vacuum (B) gas filled (C)	Rated initial lumens 1925	Rated initial lumens 1926	Approx. mean lumens throughout life 1925	Approx. mean lumens throughout life 1926	Approximate No. of lamps 1925	Approximate No. of lamps 1926	Per cent of annual demand 1925	Per cent of annual demand 1926	Per cent change
					30-34 Volt Range						
15	S-17	B	155	160	135	140	209,000	424,000	11.25	17.57	+56.1
15	G-18½	B	141	144	123	125	411,000	497,000	22.07	20.60	— 6.7
15	PS-16	C	151	151	142	142	74,000	54,000	4.00	2.24	—44.0
15	A-17	C	...	149	...	134	....	110,000	.....	4.56	....
25	S-17	B	273	273	219	219	82,000	106,000	4.42	4.39	— .7
25	G-18½	B	243	243	207	207	118,000	221,000	6.34	9.16	+44.5
25	PS-16	C	300	300	285	285	284,000	255,000	15.27	10.57	—30.8
25	A-19	C	...	295	...	272	....	88,000	.....	3.65	....
50	PS-20	C	705	735	670	577	252,000	240,000	13.53	9.95	—26.4
50	A-21	C	...	725	...	667	....	51,000	.....	2.12	....
75	PS-22	C	1,215	1,238	1,150	1,127	26,000	50,000	1.42	2.07	+45.7
100	PS-25	C	1,700	1,690	1,610	1,538	12,000	46,000	.66	1.91	+189.5
100	A-23	C	...	1,790	...	1,629	....	10,000	.....	.41	....
Total			...	...	...	.....	1,468,000	2,152,000	78.96	89.20	....
					60-65 Volt Range						
15	S-17	B	144	158	125	137	34,000	15,000	1.80	.62	—65.5
15	G-18½	B	129	134	112	116	130,000	75,000	6.99	3.11	—55.5
15	A-17	B	...	135	...	120	....	12,000	.....	.50	....
25	S-17	B	255	255	204	204	82,000	46,000	4.43	1.91	—57.0
25	G-18½	B	235	235	200	200	28,000	26,000	1.50	1.08	—28.0
25	PS-16	C	267	267	253	253	24,000	2,000	1.30	.08	—93.9
25	A-19	C	...	250	...	238	....	24,000	.....	.99	....
50	PS-20	C	600	600	545	545	78,000	47.000	4.18	1.95	—53.4
50	A-21	C	...	615	...	558	....	3,000	.....	.12	....
75	PS-22	C	1,013	1,043	913	940	10,000	8,000	.55	.33	—40.0
100	PS-25	C	1,480	1,500	1,305	1,322	5,000	3,000	.29	.12	—58.7
100	A-23	C	...	1,470	...	1,297	....	600	.....	.025	....
Total			...	...	...	.....	391,000	261,000	21.04	10.80	....
Grand Total			...	...	...	.....	1,859,000	2,413,000	100.00	100.00	....

32 volts for use with systems that do not employ lamp regulators. Your Committee has felt, therefore, that until further developments are made which will permit the railroads reaching an agreement to use a single voltage lamp in the 30-34 volt range that the three voltages as adopted by the Association last year be adhered to, viz: 32, 34 and 64 volts.

TABLE 3—DISTRIBUTION OF TRAIN LIGHTING LAMP DEMAND BY VOLTAGE

Volts	Per cent of voltage group demand 1925	Per cent of voltage group demand 1926	Per cent of total demand 1925	Per cent of total demand 1926
	30-34 Volt Range			
30	2.92	2.2	2.30	1.96
32	73.12	72.4	57.75	64.58
33	11.85	13.7	9.35	12.29
34	12.11	11.7	9.56	10.37
Total	100.00	100.0	78.96	89.20
	60-65 Volt Range			
60	10.21	18.2	2.15	1.95
64	56.77	62.9	11.94	6.82
65	33.02	18.9	6.95	2.03
Total	100.00	100.0	21.04	10.80
Grand Total	......	.....	100.00	100.00

With about 300,000 of the new type of train lighting lamps having been furnished the railroads up to July 1st and the fact that their use is very rapidly extending, your Committee feels that action can be taken this year by the Association in approving the gradual substitution of the new line of train lighting lamps in place of the older types as manufacturing conditions permit. There is, however, a growing demand for a 75 watt lamp and because of the limitation in generator capacity on a large number of cars the need for this size of lamp will probably be a permanent one. As this size has not as yet been produced in the A bulb it is proposed to retain the present lamp in the PS-22 bulb until decision is reached as to whether the 75 watt lamp in A bulb will be added to the new line. It is therefore recommended that train lighting lamps as given in Table 4 be substituted for Table 4, Paragraph 1, Section V of the Electric Train Lighting Section of the Manual.

TABLE 4

Size in watts	Voltages	Bulb	Vacuum (B) or gas filled (C)
15	32, 34	A-17	C
15	64	A-17	B
25	32, 34, 64	A-19	C
50	32, 34, 64	A-21	C
75	32, 34, 64	PS-22	C
100	32, 34, 64	A-23	C

3. DEVELOPMENTS IN INCANDESCENT LAMPS FOR LOCOMOTIVE LIGHTING SERVICE

In last year's report your Committee called attention to the changes being made in the types of lamp bulbs used in locomotive lighting service. These have now progressed to the extent that the 60 and 100 watt headlight lamps for switching locomotive service are being supplied entirely in P-25 bulbs, while the substitution of the P-25 for the G-30 bulb for the 250 watt headlight lamp is taking place rapidly. The use of the 15 watt cab lamp in S-14 bulb in place of the S-17 bulb is growing more slowly. Considering the advantages of this lamp due to its much smaller dimensions and the fact that it has been developed at the request of the railroads, your Committee recommends that those who have not made the change give the matter early consideration as obviously it is a disadvantage to both the users and the manufacturers to maintain a large production of two types of lamps for the same service. In Table 5 is shown the total demand in this country for lamps in the locomotive lighting schedule for the year ending July 1st.

TABLE 5—DEMAND FOR LOCOMOTIVE LIGHTING LAMPS FOR YEAR ENDING JULY 1, 1926

Size of watts	Bulb	Rated initial lumens	Approximate No. of lamps	Per cent of total annual demand
	Headlight Lamps			
60	P-25	714	20,739	6.2
100	P-25	1,470	113,611	33.8
250	G-30 & P-25	4,250	201,267	60.0
Total			335,617	100.0
	Cab Lamps			
15	S-17	107	1,068,936	82.4
15	S-14	135	228,918	17.6
Total			1,297,854	100.0

In Table 6 is shown the distribution of the headlight demand according to voltage, in which it will be noted that the 32 volt lamps constitute 90.3 percent of the total.

TABLE 6—DISTRIBUTION OF HEADLIGHT LAMP DEMAND BY VOLTAGE

Volts	Approximate No. of lamps	Per cent of total annual demand
30	5,052	1.5
32	303,053	90.3
33	4,794	1.4
34	22,718*	6.8
Total	335,617	100.0

* The demand for 34 volt lamps was actually less than this as the group contains some lamps for which the record of the actual voltage supplied was not available.

The Association in approving last year the 250 watt lamp in the P-25 bulb as an alternate standard also specified that there should be a distinctive differentiation between the 250 and 100 watt headlight lamps in the P-25 bulb. In this connection consideration has been given to (a) placing a distinctive marking on the 100 watt lamp bulb, (b) inside frosting of the 100 watt lamp bulb, and (c) recently to furnishing the 100 watt headlight lamp in the A-21 bulb. This latter scheme is still in the experimental stage of its development and service experience will be necessary to determine whether its performance can be made successful. As reported by the Committee on Locomotive Electric Lighting the

inside frosted lamp for switching locomotive headlight service appears to possess a decided advantage from the viewpoints of better diffusion of the light in front of the locomotive and reduction in glare. Regardless of the possibility of developing a satisfactory 100 watt headlight lamp in a different style of bulb your Committee recommends the railroads experiment on a larger and wider scale with the inside frosted lamp for this service. Pending further developments it is felt that the present 100 watt P-25 bulb lamp should have the heavy etched ring around the label to serve as a more distinctive marking to aid in readily identifying the switching from the road locomotive headlight lamp.

In view of the development during the present year your Committee recommends the adoption of the 250 watt, 32 volt, P-25 bulb headlight lamp for road locomotive service and the 15 watt, 33 volt, S-14 bulb cab lamp as standard for locomotive lighting service. For the lamp for switching locomotive service it is felt further experience with the developments that have been proposed will be necessary before action should be taken relative to standardizing a lamp for this service.

TABLE 7—NEW STANDARD LINE INCENDESCENT LAMPS INSIDE FROSTED

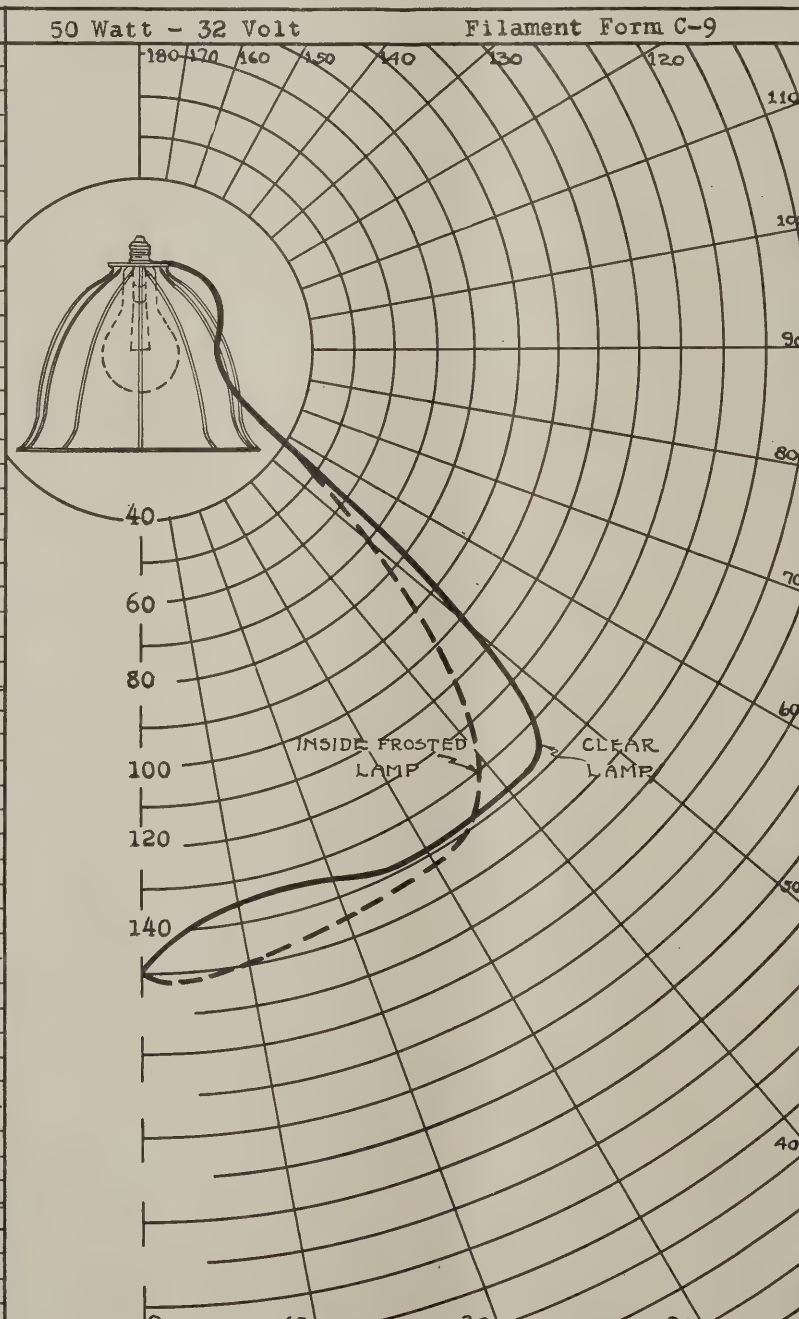
Watts	Bulb	Base	Mazda "B" or Mazda "C"	Max. overall	Light center length	Rated initial lumens
			General Lighting Service 110, 115, & 120 *Volts*			
15	A-17	Med	Mazda B	3⅝	2⅜	117
25	A-19	Med	Mazda B	3 15/16	2½	223
40	A-21	Med	Mazda B	4 7/16	2⅞	380
50	A-21	Med	Mazda C	4 15/16	3⅜	540
60	A-21	Med	Mazda C	5¼	3¾	666
100	A-23	Med	Mazda C	6 1/16	4⅜	1,320
			High Voltage Lighting Service 220, 230, 240 & 250 *Volts*			
25	A-19	Med	Mazda B	3 15/16	2½	213
50	A-21	Med	Mazda B	4 7/16	2⅞	440
100	A-23	Med	Mazda C	6 1/16	4¾	1,070

4. DEVELOPMENTS IN INCANDESCENT LAMPS FOR GENERAL SERVICE AND OTHER SPECIAL USES OF INTEREST TO RAILROADS

New Line of Lamps. At last year's Convention your Committee called attention to the introduction of a new line of incandescent lamps in the A type of bulb with inside frosting. During the past year a complete line of lamps in the new bulb and

PS-20 Clear Lamp

APPARENT CANDLEPOWER		
ANGLE	BARE LAMP	LUMINAIRE
0		147
5		138
15		133
25		138
35		137
45		136
55		42
65		29
75		20
85		18
90		18
MLHCP		66
95		19
105		21
115		23
125		24
135		24
145		22
155		21
165		20
175		20
180		20
MUHCP		22
MSCP	59	44
ZONAL LUMENS		
ZONE	BARE LAMP	LUMINAIRE
0-10		13
10-20		38
20-30		64
30-40		86
40-50		105
50-60		38
60-70		29
70-80		21
80-90		20
90-100		21
100-110		22
110-120		23
120-130		22
130-140		19
140-150		14
150-160		9
160-170		6
170-180		2
TOTAL	735	552
ZONE	LUMENS	% TOTAL BARE CLEAR LAMP
0-60	344	46
0-90	414	56
90-180	138	19
0-180	552	75



A-21 I.F. Lamp

APPARENT CANDLEPOWER		
ANGLE	BARE LAMP	LUMINAIRE
0		151
5		152
15		146
25		142
35		139
45		100
55		42
65		27
75		20
85		17
90		18
MLHCP		62
95		19
105		22
115		24
125		25
135		25
145		24
155		24
165		23
175		23
180		23
MUHCP		23
MSCP	58	43
ZONAL LUMENS		
ZONE	BARE LAMP	LUMINAIRE
0-10		15
10-20		41
20-30		66
30-40		87
40-50		77
50-60		38
60-70		27
70-80		21
80-90		19
90-100		21
100-110		23
110-120		24
120-130		23
130-140		19
140-150		15
150-160		11
160-170		7
170-180		2
TOTAL	725	536
ZONE	LUMENS	% TOTAL BARE CLEAR LAMP
0-60	324	45
0-90	391	54
90-180	145	20
0-180	536	74

Fig. 2—Distribution Curves With Sudan Opal Reflector No. 18678

finish has been placed on the market in the 32, 64, 110 and 220 volt ranges in all standard wattages up to and including 100 watts. The new lamps for general and high voltage lighting service are shown in Table 7, the train lighting lamps being listed in Table 4. The manufacturers report that during the past year there have been shipped over 50,000,000 of the new type of lamps covering all classes of purchases, including many railroads. As these lamps will gradually replace the existing types it is recommended that those railroads who are not yet using them try them out.

Lamps for Rough Service. The lamp manufacturers have recently developed a new rough service lamp for extension cord use. The rating of this lamp is 50 watts, 110, 115 and 120 volts A-19 bulb inside frosted and has a new and improved type of filament construction. Tests have shown that it is very much superior to any type of lamp previously made when used under conditions where it is subject to shock.

Lamps for Motor Coach Lighting. The increased use of motor coaches by railroads has made the question of lamps for that service of interest. A lamp has been developed especially for the interior lighting of motor coaches. It is a 21 candlepower, 12-16 volt, S-11 bulb DC bayonet candelabra base, Mazda 1142, similar in construction to the auto head lamp but is designed for a somewhat lower efficiency to give longer life. This lamp, or the 15 candlepower, 12-16 volt, S-8 bulb DC bayonet candelabra base lamp, is also recommended for destination signs and step lights.

The 21 candlepower, 12-16 volt, S-11 bulb SC bayonet candelabra base lamp, Mazda 1141, is recommended for headlights and stop signals. The 21-21 candlepower, 12-16 volt, S-11 bulb DC bayonet candelabra base Mazda headlight lamp is also used for head lamps especially designed for double filament lamps.

Auxiliary parking lights, tail lights, instrument board lamps, fare box lamps and markers are taken care of by the three candlepower, 12-16 volt, G-6 bulb DC bayonet base lamp Mazda 68.

Lamps for Electric Hand Lantern Service. As the use of electric hand lanterns for various purposes is increasing among the railroads as well as other fields, it is desired to call attention to the lamps that are offered as standard for this service.

The 5 volt, 0.15 ampere, G-4½ bulb miniature screw base lamp for use with four cell lantern batteries.

The 1.25 volt, 0.60 ampere, G-4½ bulb, miniature screw base, Mazda 19 lamp for use with one cell standard No. 6 batteries.

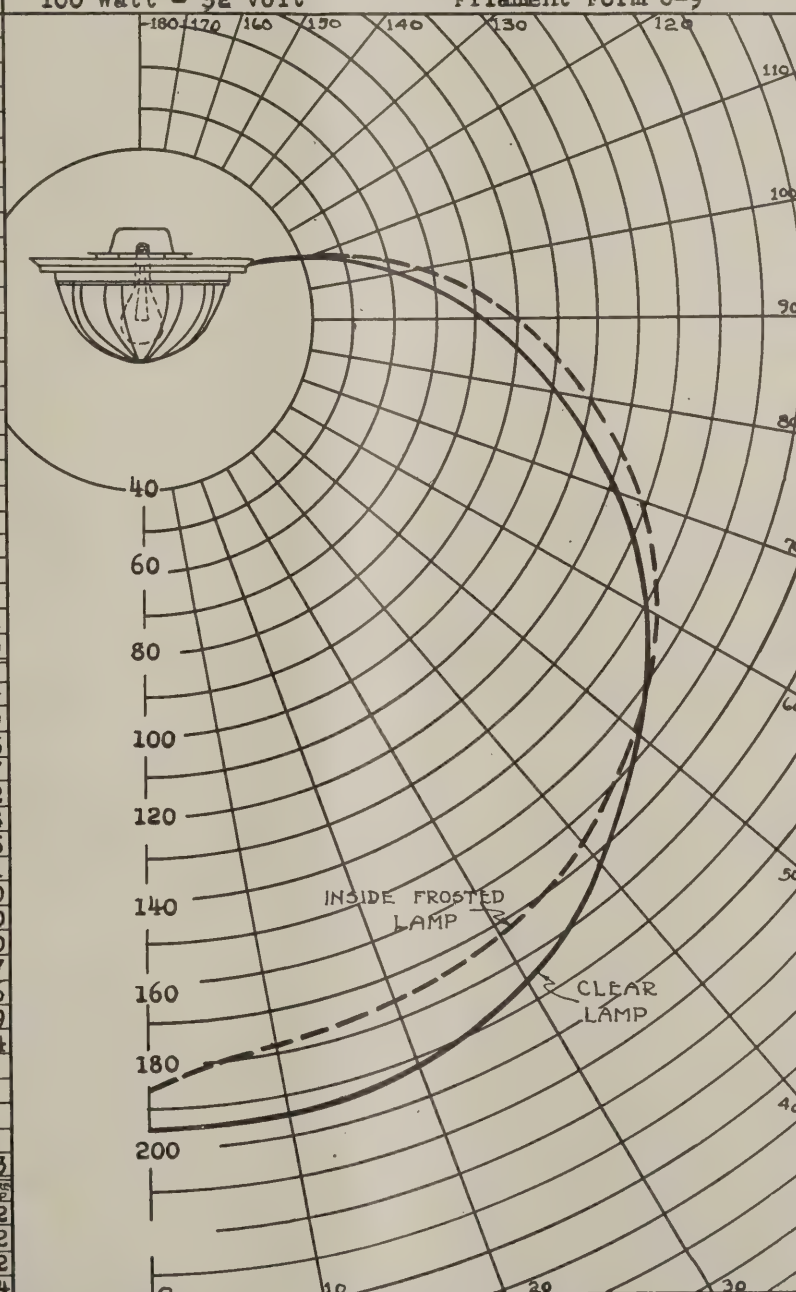
PS-25 Clear Lamp

APPARENT CANDLEPOWER		
ANGLE	BARE LAMP	LUMINAIRE
0		194
5		194
15		193
25		187
35		179
45		166
55		150
65		132
75		113
85		92
90		81
MLHCP		141
95		73
105		54
115		36
125		21
135		5
145		
155		
165		
175		
180		
MUHCP		31
MSCP	135	86

ZONAL LUMENS		
ZONE	BARE LAMP	LUMINAIRE
0-10		19
10-20		55
20-30		87
30-40		112
40-50		128
50-60		135
60-70		131
70-80		120
80-90		100
90-100		80
100-110		57
110-120		36
120-130		19
130-140		4
140-150		
150-160		
160-170		
170-180		
TOTAL	1690	1083

ZONE	LUMENS	% TOTAL BARE CLEAR LAMP
0-60	536	32
0-90	887	52
90-180	196	12
0-180	1083	64

100 Watt - 32 Volt Filament Form C-9



A-23 I.F. Lamp

APPARENT CANDLEPOWER		
ANGLE	BARE LAMP	LUMINAIRE
0		184
5		179
15		178
25		175
35		170
45		160
55		149
65		138
75		120
85		99
90		90
MLHCP		141
95		79
105		58
115		36
125		19
135		8
145		
155		
165		
175		
180		
MUHCP		33
MSCP	142	87

ZONAL LUMENS		
ZONE	BARE LAMP	LUMINAIRE
0-10		17
10-20		50
20-30		81
30-40		107
40-50		124
50-60		134
60-70		137
70-80		127
80-90		108
90-100		86
100-110		61
110-120		36
120-130		17
130-140		6
140-150		
150-160		
160-170		
170-180		
TOTAL	1790	1091

ZONE	LUMENS	% TOTAL BARE CLEAR LAMP
0-60	513	29
0-90	885	49
90-180	206	12
0-180	1091	61

Fig. 3—Distribution Curves With Moonstone Bowl No. 51646

The 2.4 volt, 0.80 ampere, G5½ bulb, miniature screw base, Mazda 35, lamp, for use with two cell standard No. 6 batteries.

Gauge Lamps for Electric Locomotives and Motor Cars. For electric locomotives and motor cars using 600 volt lighting circuits with lamps burning in series there has not until recently been available a standard line of gauge lamps. As these gauge lamps are not listed in the manufacturers' standard lamp schedules it has been thought desirable to include them in this report for the information of those who have need for a lamp of this type. Table 8 covers these lamps.

Table 8—Standard Gauge Lamps for Burning in Series with Street Railway Lighting Service Lamps.

Amperes	Volts	Bulb	Base	Service
.214	3	T-3	Min. Scr.	In series with 23 watt lamps
.342	3	T-3	Min. Scr.	In series with 36 watt lamps
.519	3	T-3	Min. Scr.	In series with 56 watt lamps
.863	3	T-3	Min.-Scr.	In series with 94 watt lamps

Switchboard Indicator Lamps. Efforts have been made to standardize incandescent lamps used for switchboard indicators. In this connection two types have been in general use by the leading manufacturers of switchboard equipment for some time, but which are now being gradually superseded with a new type of switchboard indicator and lamp. The present standard lamps are 15 watt, 140 volt, T-7 candelabra screw Mazda B lamp and 15 watt, 140 volt, T-6 candelabra screw Mazda B lamp.

The proposed new standard lamps for this service are of a low voltage type and are burned in series with a resistance unit. The new lamps for use with these resistance units are 18 volt, .11 ampere, T-4 candelabra, screw Mazda B lamp and 18 volt, .11 ampere, G-6 S.C. bayonet candelabra Mazda B lamp.

5. FLOOD LIGHTING OF RAILROAD YARDS

Your Committee has devoted most of its work this year to a continuation of the study of flood lighting as applied to railroad yards. During the past two years members of the Committee and engineers from the incandescent lamp companies and manufacturers of flood lighting equipment have visited several railroad yards to inspect flood lighting installations, these comprising the Fulton and the Clifton Forge yards of the Chesapeake and Ohio Railroad, the Markham yard of the Illinois Central Railroad, the Selkirk yard of the New York Central Railroad, the Acca and Potomac yards of the Richmond, Fredericksburg and Potomac Railroad, and the engine terminal yard of the Washington Terminal Company.

Much valuable information has been obtained but it is felt that unless accompanied by plans of the lighting installations and yards, description of operating features, illumination test data, etc., a tabulation of comparative data would be of little value, if not misleading. In general it may be said that neither the engineering nor the economic features of modern flood lighting as applied to railroad yards have been sufficiently developed to permit establishing definite standards of practice at this time. Each yard must be considered largely as a separate problem requiring its individual solution in which actual experience in laying out installations of this character plays a larger part than solely a knowledge of the engineering processes involved in making flood lighting applications.

In considering the solution of the problem of artificial illumination of outdoor areas as found in the railroad field the first step will be to segregate the various types of yards and other facilities for which flood lighting is either entirely or partially applicable. These may be roughly defined as follows:

1. Freight classification yards:
   - a—Freight yards with locomotive switching;
   - b—Hump yards using car rider system;
   - c—Hump yards using mechanical retarders.
2. Freight receiving and departure yards.
3. Passenger storage and cleaning yards.
4. Special applications:
   - a—Hump area in classification yards;
   - b—Scale houses and track approaches;
   - c—Car repair yards;
   - d—Coaling stations, ash pits, etc.;
   - e—Engine storage tracks or engine terminals;
   - f—Turntables and inner circles at engine houses;
   - g—Outside of piers and water front yards.

The work of the Committee this year has been confined to freight classification, receiving and departure yards.

Methods of Flood Lighting

The subject of the Fundamentals of Projection and Systems of Flood Lighting has been discussed in Section 6—Yard Lighting of the Lighting Practice Manual. There are several methods of lighting yards and it is difficult to lay down rigid rules which would meet all the varying conditions found in different types of yards. Costs, availability of space for the towers, track layouts and methods of yard operation are factors vitally affecting the problem and must be given equal consideration with the illumination side of the question. The following three methods of applying flood lighting to railroad yards are the ones in most common use.

(*a*) *Uni-directional Group Lighting.* Projectors are mounted in groups with the beams projecting in the same direction that traffic is moving. This method has the advantage of being free from glare and cars are seen from direct reflection. Towers are spaced from 1,000 ft. to 2,000 ft. apart. Where conditions necessitate greater spacing projectors designed for long range work should be used. Fig. 4 is an illustration of the visibility secured by direct reflection.

(*b*) *Parallel Opposing Group Lighting.* Projectors are mounted in groups with the beams projecting in both directions. By this method cars are seen by direct reflection and by silhouette due to the contrast of the background illumination and materially assisted by the specular reflection from the rails and sides of cars. Towers are placed 2,000 to 4,000 ft. apart. Where conditions necessitate greater spacing projectors of design for long range work should be used. Fig. 5 is an illustration of this method of lighting. A comparison of the relative merits of these two methods should not be made from the photographs as they do not represent comparable conditions but do bring out the inherent characteristics, to a considerable degree, of these two principles.

(*c*) *Uni-directional Distributed Lighting.* Projectors are placed on towers singly or in pairs at intervals of 250 or 500 ft. through the yard or along the sides of the yard. This system has advantages where heavy fog or dense smoke is prevalent, but is more expensive to install and maintain.

Fig. 4—Illustration of Visibility Secured by Direct Reflection

A distinct difference in visual effect exists between the first two methods which is of considerable import in planning any railroad yard lighting. Where the light is projected in the direction of traffic any possibility of dangerous glare is eliminated, since the direction of vision, so far as car riders are concerned, is away from the projectors. In the other method where light is projected against traffic visibility of objects in the yard is secured by silhouette effect, contrasting shadows, specular reflection from the rails and from the sides and tops of cars. Visibility sufficient for operating purposes can be secured at lower intensity of illumination than by the direct lighting method but the advantages are largely offset by the serious glare that usually exists. However, because of the ability to space towers at greater distances and the fact that in many yards two way operation exists, the opposing group system of flood lighting is the more generally used. With either method visibility would be very materially increased if a white band or suitable white target were painted on the ends of all cars. Considering the amount of damage to cars and contents in handling through hump yards the cost of providing such a marking on cars would be small compared with the benefit to be gained.

Illumination Intensities

After considerable investigation leading authorities on yard lighting have agreed that the most practical method of specifying railroad yard lighting values is on a basis of lumens per square foot, this representing the lumens projected from the lighting units over the yard divided by the area in square feet.

Experience in the operation of yards equipped with modern lighting systems is as yet insufficient to determine the economical limits for the amount of artificial lighting that can be used to advantage. The intensities required with different methods of flood lighting will also vary to some extent. The values given represent good modern practice, the tendency being toward constantly increasing intensities.

For classification yards the quantity of light should fall within the range of from 0.06 to 0.15 lumens per square foot with a recommended value of 0.1 lumens per square foot. For receiving and departure yards the amount of illumination required depends largely upon local operating conditions. A range of 0.04 to 0.1 lumens per square foot will be found satisfactory. Values near the lower unit will be sufficient where employes have little work to perform in the yard and near the upper limit where extensive inspections or light running repairs are made in these yards.

In cases where speed of operation is of prime importance considerably higher values may be justified.

Laying Out Flood Lighting Installations

Determination of Number of Lighting Projectors. It is not a simple matter to determine the most economical manner for the illumination of railroad yards as the location of the towers and number of projectors will vary with the shape of the yard, the type of projectors, the amount of light thrown outside of the yard limits and other local conditions. For the preliminary determination of the number of projectors required, a reasonably accurate estimate may be made by the following simple calculation:

A=Area of yard in square feet.

I=Desired illumination in lumens per square foot.

B=Lumens in beam of projector selected, as obtained from the manufacturer's data or laboratory tests.

N=Number of projectors required.

$$N = \frac{A \times I}{B}$$

Location of Towers

Having decided upon the method of flood lighting to be used practical considerations such as the shape of the yard, track layout, method of yard operation, satisfactory available space for towers, etc., will largely determine the location of the towers. For obvious reasons the locations selected should deviate as little as possible from the ideal locations from the light distribution viewpoint. The graphical method for determining the approximate location of the lighting units will be found the most satisfactory in which the area that will theoretically be illuminated by each projector is laid out to scale on a plan of the yard. While the formulas for calculating this data are somewhat complex the manufacturers of flood lighting equipment have published technical data that will greatly simplify the work of making these layouts. After completing these studies it is always advisable to decide upon the actual location for the towers by inspection of local conditions in the yard.

Fig. 5—Illustration of Visibility Secured by Silhouette and Specular Reflection from the Rails and Sides of Cars

Hump Area. While it has been the practice to locate towers so that the stray light from the flood lighting units will illuminate the hump area it is questionable that it is the best or most economical method, particularly for large yards. Relatively high intensity is requred at the hump, its approach and lead to the yard, especially where car weighing is done. Shadows should also be avoided. This can best be accomplished by means of local lighting using RLM dome or angle reflectors preferably with dust tight covers. This can be supplemented with low power (500 watt) flood lights of the diffusing type for lighting the approach track and lead to the ladder tracks. Extreme care in locating these units is necessary to avoid objectionable glare, particularly for any units turned toward the receiving yard.

Yard Area. Where the car rider system of operation is used sufficient light is needed in the body of the yard to permit the riders to control the speed of their cuts of cars to take them to their proper destinations safely. The need for visibility for long distances is not as essential as where the mechanical retarder system is used. Serious glare in direct line of vision of the car rider should be avoided.

Experience in the operation of yards equipped with the mechanical retarder system is as yet too limited to determine the best solution of the lighting problem involved and further study and experimenting will be necessary before definite recommendations can be submitted. For this type of yard the lighting conditions are somewhat different. The retarder operators must see the cuts of cars as they approach to judge their speed, as they pass to check cutting lists, and to follow them after they pass. There should be sufficient illumination in the body of the yard to permit the operators of the last retarders observing the distance the cars must travel so as to regulate the speed necessary to cover this distance properly.

By locating the first tower nearer to the ladder tracks its effectiveness in lighting the yard area is increased, the distance it covers the yard being lengthened by the amount the tower can be moved forward from the hump location that is necessary when using the light from it for illuminating the hump area. It is desirable to place the tower near the center track of the yard so as to project the light as nearly parallel with the tracks as practicable. For very wide yards it may be found advisable to use two towers at the head of the yard. Where the mechanical car retarder system is used lighting of the front end of the approaching cuts of cars may be secured by means of medium or wide angle projectors placed on or near the retarder control towers and directed against traffic. To illuminate the sides of cars as they pass as well as increase the illumination on the retarders wide angle projectors of short range on or near the last control towers are recommended. Extreme care is necessary in placing these units as well as locating the main tower or towers at the head of the yard to avoid the light from the projectors being in direct line of vision of any of the retarder control operators. In this connection suitable shields over the windows in the control towers may be of considerable assistance in eliminating glare from the projectors. For some yard layouts it may be found advantageous both from the point of view of reduction in cost as well as more effective distribution of light to consider combining the lighting towers with certain of the control towers.

The location of the remaining towers in the yard will depend upon the method of lighting being employed, shape of the yard, effective range of the lighting units, satisfactory available space for towers, etc. Because of the extent to which range of vision is reduced by glare it is felt that uni-directional method of lighting is better suited where mechanical retarders are used. Local conditions play such an important factor that no specific recommendations can be made covering location of towers in the yard.

Mounting Height of Projectors

One of the most common and serious errors made in flood lighting installations is too low a mounting height of the projectors. At best there is always more or less objectionable glare with the use of flood lights and this can be mitigated only by adhering to high mounting height. As minimum mounting heights, 35 feet for the lower power (500 watt) short range projectors, 70 feet for the nominal 12 to 14 in. projectors using standard lamps, and 90 feet for the larger projectors are recommended. For nearly all cases greater heights can be economically justified, especially where long range projectors with concentrated filament flood lighting lamps are used.

Lamps for Flood Lighting Service

It is recommended that the regular general lighting service lamps of 500, 750 and 1,000 watt sizes will be used as standard for flood lighting in the railroad field. Where very long range is necessary the 1,000 watt G-40 bulb concentrated filament flood lighting lamp is proposed as a standard for this service. The use of the 250 watt G-30 bulb and 500 watt G-40 bulb flood lighting lamps are not recommended in the railroad field on account of representing special and inherently relatively shorter life lamps.

Flood Lighting Projectors

In designing or selecting flood lighting projectors for railroad use it should be recognized that they will be subjected to severe service from the viewpoint of deterioration due to atmospheric conditions in which they will be placed and the fact that on account of their relative inaccessibility they will receive the minimum as well as indifferent attention for cleaning, maintenance, adjustment, etc. In general the following features should be considered:

Reflectors. Reflectors should be as efficient as practicable, consistent, however, with freedom from tarnishing and permanent deterioration due to the adverse conditions in which they will be placed. They should be so mounted in their cases that they may be removed if replacement becomes necessary.

Cases. Cases should be of rugged construction, weatherproof, dust tight, of rust resisting material throughout, and also capable of withstanding the action of gases and smoke. The side trunnion method of mounting is preferable and should be employed in the larger sizes of projectors.

Adjustments. Means used for focusing the lamp or training the projector should be such that necessary adjustments can be made without the aid of tools.

Accessibility. The present tendency for locating flood lights on the towers is to place them so that they are accessible only from the rear. The units should be so designed that they may be readily relamped and cleaned under these conditions. If this is accomplished by turning over the unit, means should be provided so that it can be restored to its original position without necessity for re-spotting the direction of the light beam projected from the unit.

Range of Sizes. For lighting of outdoor areas in the railroad field it is felt that three sizes of projectors will meet the requirements, viz: a low power (500 watt) short range unit, a nominal 12 in. to 14 in. unit for use with a maximum of 1,000 watt PS-52 bulb lamp for general flood lighting purposes, and a larger size projector primarily for long range service or other conditions where the use of high powered units is desirable. This size of projector should be adapted for use both with the 1,000 watt PS-52 and 1,000 watt G-40 bulb lamps. From the viewpoint of light distribution, projectors should be available giving the usual range of narrow beam to medium beam distribution and also to provide diffused distribution or wide angle distribution to take care of the requirements that are likely to be met in this class of service.

Light Distribution Curves. As the relative merits of the flood lighting projector from an illumination viewpoint can be largely ascertained from a study of the light distribution curves, it is essential that a common method of photometering the flood lighting units be followed by all so as to insure the data being on a comparable basis. Apparently such a standard practice is not in universal use. While it is not within the scope of the activities of this Association to establish laboratory standards of procedure of this character, a suggested method for photometering flood lights is offered in Appendix A for the consideration of manufacturers of flood lighting equipment and others interested.

APPENDIX A

Suggested Method for Photometering of Flood Light Projectors

Lamp. Lamp to be of current manufacture, aged sufficiently to establish candle power and held at the correct lumens according to manufacturers' schedule of the period of test. The lamps should be within 5 percent of wattage rating when so held and should conform to manufacturers' tolerances of source size.

Adjustment of Lamp in Unit. In general, focusing is to be done at a distance within plus or minus 10 percent of 100 ft. This specification applies to reflectors giving a narrow beam. Where the unit is smaller than 12 in. in diameter or of a wide angle type, the distance may be reduced without serious error. The lamp should be adjusted in the fixture to give the narrowest symmetrical beam. The determination of reference lines for the beam can be made visual when feasible. In some cases it will be necessary to determine the reference lines by setting the beam so that the beam is bisected both horizontally and vertically.

Observations. The beam should be divided by four diameters, one horizontal, one vertical, and two bisecting the quadrants at right angles. Readings should be made along each diameter at one degree intervals by sighting on a test chart subtending one degree solid angle. This may be done by any convenient method which will give an average value, as for example, viewing with a photometer covering desired field. The beam limits are to be taken as 10 percent of the maximum candle power value obtained.

Reporting Results. Lamp lumen output should be reported on curve sheet. Source dimensions and filament type should also be stated. It is recommended that a photograph of filament construction, preferably to scale, be included.

An average curve obtained from averaging the values for the four diameters according to distance from reference point should be plotted, showing degrees from center of beam as horizontal values and apparent beam candle power as vertical values. It is recommended that output lumens and output efficiency within the beam be recorded.

General. It is recommended as desirable that curves be obtained on more than one unit and more than one lamp in order that the curves may represent the average product of the manufacturer.

Respectfully submitted,

COMMITTEE ON ILLUMINATION.

Report of Committee on Application of Radio to Railway Service

Increase in Number of Broadcasting Stations Has Greatly Improved Reception on Moving Trains

Committee:—

Ernest Lunn, chairman, electrical engineer, Pullman Company; S. D. Dimond, chief electrician, Minneapolis, St. Paul & Sault Ste. Marie; John Gordon, assistant electrical engineer, Canadian National; F. O. Marshall, assistant superintendent, yard department, Pullman Company; Carl A. Berg, chief electrician, Boston & Albany; G. W. Olive, radio engineer, Canadian National.

To the Members:

During the past two years the attitude of the public toward radio has materially changed. Prior to that time everyone was striving for distant reception and maximum volume to a large extent, ignoring quality. During the past two years broadcasting stations have materially improved, and there are now in the country a large number of super power stations which give greatly improved reception over a much wider radius.

The influence of these stations upon radio on moving trains should be decidedly for the better, as reception from local stations is always, from a quality standpoint superior to that from any distance unless the transmitting station is exceptionally powerful. These powerful stations also permit much better reception in summer time than was heretofore possible.

Many improvements have been made in the audio amplifying and loud speaker portions of the receiver. The better audio frequency transformers at the present time reproduce satisfactorily the frequencies over the entire musical scale and also overtones and harmonics.

The better manufacturers are also turning out power tubes that will handle the necessary volume without distortion. Of these, the better known are the UX-120, UX-112, UX-171, and UX-210, all of these having a particular use, depending upon the individual requirements.

The cone type loud speakers at the present time on the market are superior to the old horns, as the cones cover the audio frequency range, whereas the horns usually worked best at the middle part of the musical scale.

There have also been placed on the market recently several new detector tubes that show a decided improvement. Their A battery current consumption is much lower, they will handle a greater volume, and the tone quality is also improved.

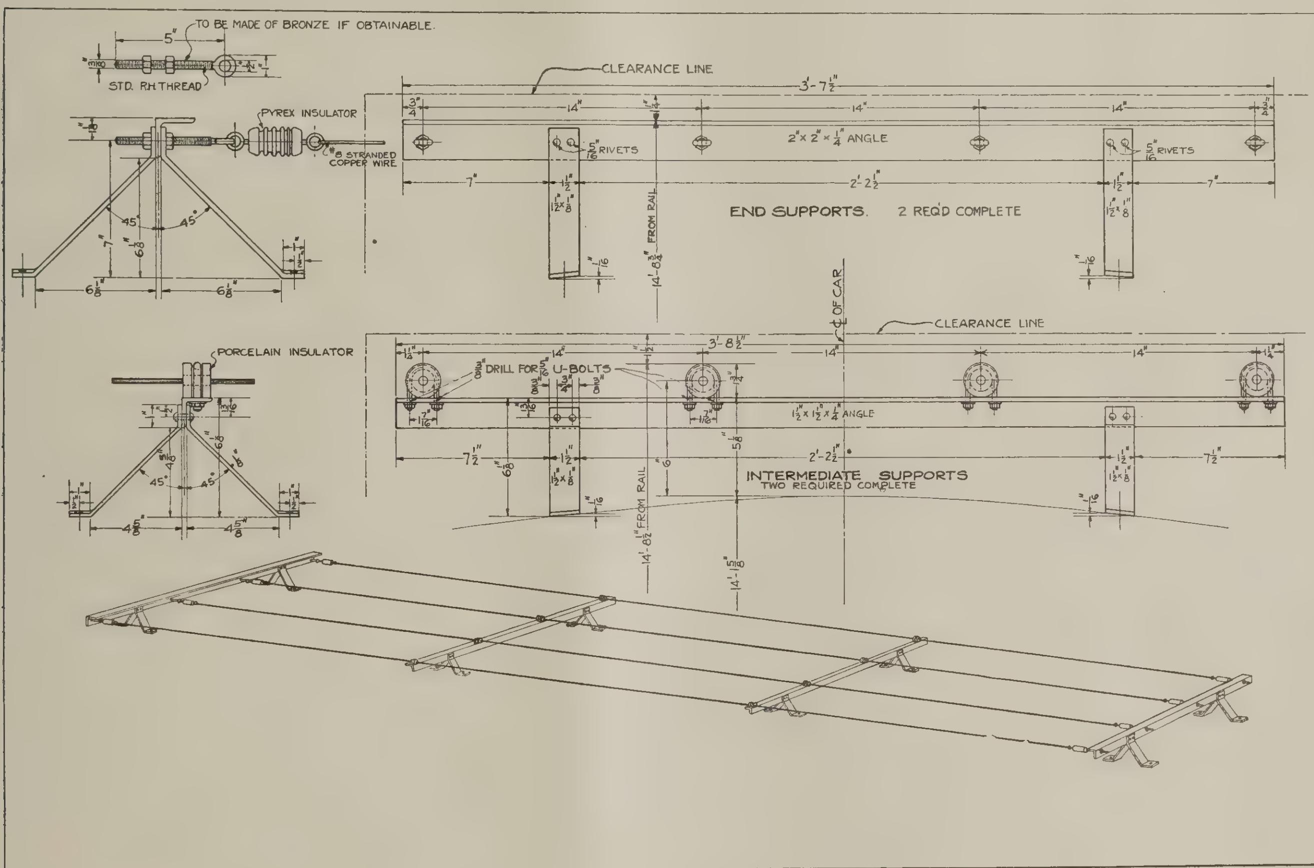
The tuning and radio frequency portions of the circuits have gone through a period of development, and it is possible at the present time to obtain sets having much greater sensitivity and selectivity with a much greater gain in amplification for the number of tubes used. Shielding is being used extensively, and on some of the sets practically true cascade amplification is obtainable.

The super heterodyne has been developed also, and it is possible to obtain these sets which are usually quite easy to tune and very sensitive.

On the ordinary radio frequency sets, the present device seems to be toward single dial control. This is obtained at some sacrifice in efficiency but makes the set much easier to tune for the average operator.

No revolutionary improvements or developments are anticipated for the near future, and it is entirely possible that during the next year progress will be confined to further refinement of existing apparatus.

In the early part of this year we put into special service three complete trains comprised mostly of Pullman Cars. Each train included one car devoted entirely to the entertainment of passengers with such facilities as library, moving pictures, dancing, musicals, gymnasium, etc. The musical instruments being one



Radio Antennae for Railway Passenger Cars

Credenza Model Orthophonic Victrola and one radio receiving outfit.

The object in this case was to furnish entertainment for the passengers while on extended tours by rail lasting from three to five or six weeks. There is a reasonable variety of entertainment offered and of a larger scope than has heretofore been employed in similar service.

In the selection of radio receiving outfits several demands had to be met, among which the most important are as follows: It had to be simple in operation so that the car attendant could operate and take care of it while on trips; it had to be able to give considerable volume suitable for dancing and without interference from the noises of the car moving at relatively high speeds; the auxiliary equipment had to be dependable and easily maintained by inexperienced parties; it had to be very selective in tuning and the quality of reception had to be good.

All three cars were fitted with the form of antennæ as shown elsewhere in this report, it being arranged for a simple conversion from loop to antennæ or vice versa. In all cases the lead-in is taken off near one end and carried through the deck panel under the eaves and extends down through the side wall of the car to the receiver. Number 10 gauge stranded phosphorus bronze wire was used for the antennæ.

The loud speakers on all cars were suspended from the underside of the side deck about 14 inches from the end of the room. Three standard radio receivers were installed; one unit in each "Recreation Car."

From latest reports results have been all that could be expected. It is evident a well selected set that will give sufficient volume and quality with a shorter length of antennæ and with selectivity in tuning will be the most practical layout for railroad service.

Respectfully submitted,

COMMITTEE ON APPLICATION OF RADIO TO RAILWAY SERVICE.

Report of Committee on Train Lighting

Increased Experience With Turbo-Generator on Locomotive for Train Illumination Indicates 32-Volts as Desirable Potential

Committee:—

P. J. Callahan, chairman, supervisor, car and locomotive electric lighting, Boston & Maine; A. E. Voigt, car lighting engineer, Atchison, Topeka & Santa Fe; J. L. Minick, assistant engineer, Pennsylvania System; F. O. Marshall, assistant superintendent, yard department, Pullman Co.; R. E. Gallagher, assistant electrical engineer, Louisville & Nashville; F. J. Hill, chief electrician, Michigan Central; G. W. Wall, electrical engineer, Delaware, Lackawanna & Western; L. S. Billau, assistant electrical engineer, Baltimore & Ohio.

TO THE MEMBERS:

Your Committee was directed to present revisions and additions to the present standard practice, also to submit all available information concerning locomotive train lighting. To this end, the following is submitted for your consideration:

Belt Clearances

Recommend that the belt clearance as given on Page 45, Sec. C, 1926 issue of manual, be revised to read as follows: With all parts of the car and axle generator, affecting the clearances, in the same position as when new; with the maximum belt tension to drive load, and with the generator in any service position with respect to the car body, the minimum clearance from any part of the belt to

	End sill		Brake beam		To any other part of car
	Over	Under	Over	Under	
Truck supported	1¼"	1½"	2"	1½"	1½"
Body supported	1½"	2½"	2¾"	1½"	1½"

Recommend that steam drips be located on opposite side of car from generator, pulley and at least 5 ft. from generator.

Axle Pulley Axle

Recommend that a rough turned axle be used for mounting axle pulleys, to avoid possibility of eccentric or loose mounting of pulley.

Pulley Centers

Recommend that distance between center of dynamo pulley and axle pulley for body hung generators, be 6 ft. in order that belt life be increased through greater friction, and lesser necessary tension.

Axle Generator

1926 Manual—Page 64—Sec. J.

Recommend that ball-bearing sizes for controlled speed generators, be omitted. Stone equipment no longer being manufactured.

Recommend that No. 410 Pulley End, and No. 408 for Commutator End, be added to the standard list of ball bearings that appear on Page 64, Sec. J, Manual of 1926. This to permit of the inclusion of the E. S. B. Standard.

Recommend that the generator pulley for sleeve bearing generators as shown on Page 39, Fig 5 V-5 be eliminated as obsolete, inasmuch as there are very few sleeve bearing generators in service.

Recommend that the shaft head or pulley seat for sleeve bearing generators as shown on Page 43, Fig. 5 V-9 be eliminated as obsolete, inasmuch as there are very few sleeve bearing generators in service.

Recommend that generator pulley end housing be so designed as to permit the removal of the head without the necessity of removing the bearing from the shaft.

Page 47—Sec. 6—Par. B.

Substitute No. 2 A. W. G. for size of wire, and amend to read as follows: Shall be covered with two weatherproof braids or a rubber jacket, and shall be so supported as not to impose strain on terminals.

Generator Regulator—Automatic Switch

Page 66—Sec. 5—Par. J.—Manual of 1926.

Recommend be amended to read—The generator regulator automatic switch shall be set to close at any and all operating temperatures at not more than 1 volt above battery voltage.

Voltage Drop

Recommend that the voltage drop between battery and lamp regulator panel be limited to ½ volt for normal lamp load. This drop can be maintained in all services, with the possible exception of dining and official cars, with the use of No. 2 A. W. G. wire. By limiting this drop to ½ volt, it will be possible in many instances to eliminate one cell per battery.

Interchangeable Generator Support

In view of the fact that all axle generator manufacturers have developed an interchangeable generator support, permitting of the application of any make of axle generator, your Committee suggests that this information be inserted in catalogs, etc., of each manufacturer, together with the necessary information as to dimensions that must be used in attaching the generator and tension support to the car body.

Rubber Faced Pulleys

No further data has been received in connection with the service obtained from rubber-faced pulleys. There are numerous applications which have been made during the past year. Improved methods for applying the rubber face have been developed, and it is hoped that sufficient data will be available after the coming Winter.

Your Committee feels that no definite recommendation can be made at this time.

Generator Leads

It is desired to call attention to the fact that a 3-conductor cable, with a heavy rubber jacket consisting of 2—No. 2 and 1—

No. 8 wires is being manufactured for use between generator and terminal block on car. Several roads have adopted this cable as standard and report very satisfactory results.

LOCOMOTIVE TRAIN LIGHTING

The lighting of suburban and branch line trains from a turbo-generator mounted on the locomotive has reached a point where your Committee feels that special attention should be given to it, with regard to assisting in bringing about a standardized installation.

In the past ten or more years, these applications have been applied in a manner best fitted to meet the local conditions. The size of turbo-generator, the voltage, size of train wires, the number and location of lights, has varied considerably, until today we have over 1,200 turbo-generators varying in size from 1½ kw. to 7½ kw. with voltages varying from 32 to 110.

The operation of this equipment has been very satisfactory and the maintenance cost very low, which tends materially to increase its attractiveness.

While there are in service a large number of 1½ kw., 2 kw. and 3 kw. generators, a 7½ kw. is now being applied in practically all installations which permits of handling conveniently ordinary trains of from 10 to 12 suburban cars with additional capacity for from 3 to 5 cars in emergencies.

For the larger applications of this form of lighting, including sleeping, parlor, mail and dining cars, requiring a battery for each, or for every other car, 15 kw. turbos are being developed.

At the present time one road is engaged in the application of this form of lighting for main line equipment, consisting of sleeping, parlor, dining and observation cars. For this year's report, emphasis is being placed on the design of suburban equipment and the possibility of the further development of this form of lighting will be investigated as information is received.

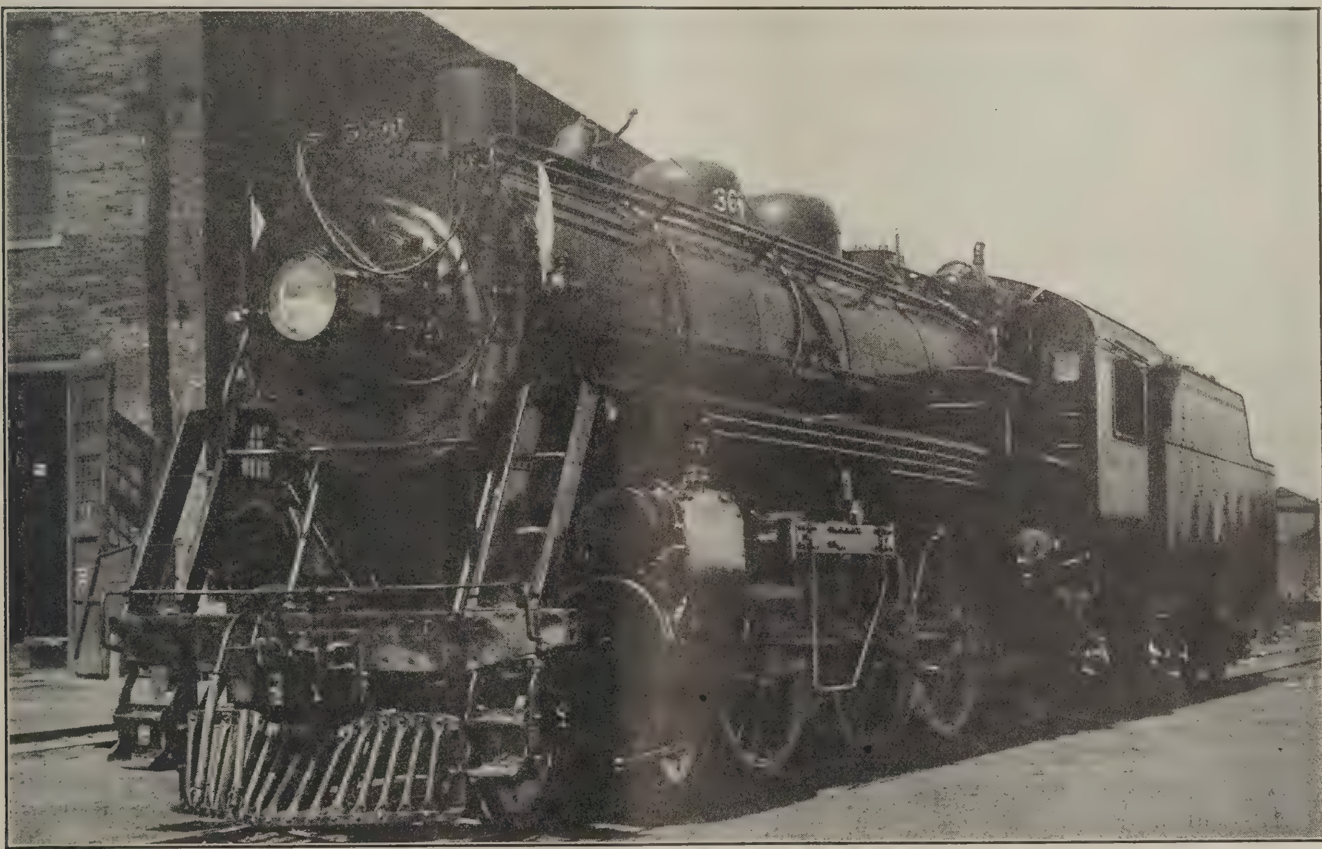
The generator voltage variation of from 32 to 110 volts has been brought about through local conditions. It is, of course, apparent that with 110 volts the line drop is considerably reduced, thereby allowing the use of a much smaller train line wire at a correspondingly less cost. The 64 volt installation is in extensive use, although the line drop is materially increased, together with an increased cost of wire. This voltage is practically standard with Locomotive Train Lighting installation. However, there are a number of points in favor of a 32 volt installation, in spite of its comparatively high first cost. The fact that 32 volts is being used in axle lighting permits of handling but one voltage lamps, permits of a cheaper battery installation, where batteries are required, reduces the maintenance cost of batteries and permits of these cars being attached to axle lighted equipment, without the necessity of changing lamps and at a time when there would possibly be no one available to remove the lamps.

The necessity for auxiliary batteries is largely governed by the particular service. There are instances where cars equipped with battery auxiliary and cars with no auxiliary are being operated in the same service. However, in one particular case, the battery is also being used with a heat control equipment.

Except in extreme cases, there appears to be no particular need for battery auxiliary where locomotives are made up on the trains in the yards. The steam for turbo is always available when train is in service, and with the proper inspection, should take care of the cars without serious interruption.

The maintenance cost of this equipment is very small. The locomotive cost is not increased a great deal, inasmuch as the turbo-generator for headlighting must be maintained on all locomotives and the same force with few exceptions will be available for the maintenance of the larger type turbo-generator. The maintenance cost of the cars is very small, consisting principally of lamp renewals, shade renewals, etc. To insure this small maintenance cost, it is essential that sufficient consideration be given to the installation, both as to the quality of the material and the application of same.

The following data is presented for consideration, with the idea of developing a standard installation which will be available for any who might be interested.



Train Lighting Locomotive—Showing the Application on Conduit, Turbo Generator and Terminal Box

1.—TURBO-GENERATOR

A.—Characteristics

(a)—*Voltages of systems used.*

1.—While 32, 64 and 110 volt generators are available, the 64 volt generators being furnished with a 32 volt a.c. tap for headlighting, your Committee is of the opinion that a 32 volt system,

because of the fact that cars may be used for lighting with axle lighted cars, should be adopted as standard.

2.—The generators must be compounded sufficiently to care for maximum train lighting load plus line drop. It is most important that particular attention be given to this, as the proper voltage of lamps depends entirely upon it.

(b)—*Turbine must be designed to—*

1.—Be economical in steam consumption.

2.—Be accessible for regulation and inspection.

3.—Be provided with a suitable speed control.

4.—Be capable of operating over ranges of boiler pressure of from 125 to 225 lb.

(c)—*Mounting.*

1.—Weight and size of unit should be such as to permit of easy mounting of same on locomotive boiler.

2.—Should be mounted in same general position as present headlight machines, namely parallel with boiler and as close to cab as possible.

3.—Brackets or plate castings should be of sufficient thickness, as to eliminate possibility of damage to bearings, etc., through excessive vibration.

(d)—*Steam Line Construction.*

1.—Steam line should be as short as possible, in order that condensation may be reduced to a minimum.

2.—Globe valve should be installed in steam line adjacent to turbine housing to permit control of steam during inspections and prevent injury to maintainer.

Showing the Method of Applying Conduit to Rear of Tender and the Application of Dummy Receptacle

3.—Steam supply line to be so constructed as to eliminate steam pockets.

2—CONDUIT & WIRING

(a)—Size of conduit to be determined by size of train line conductors.

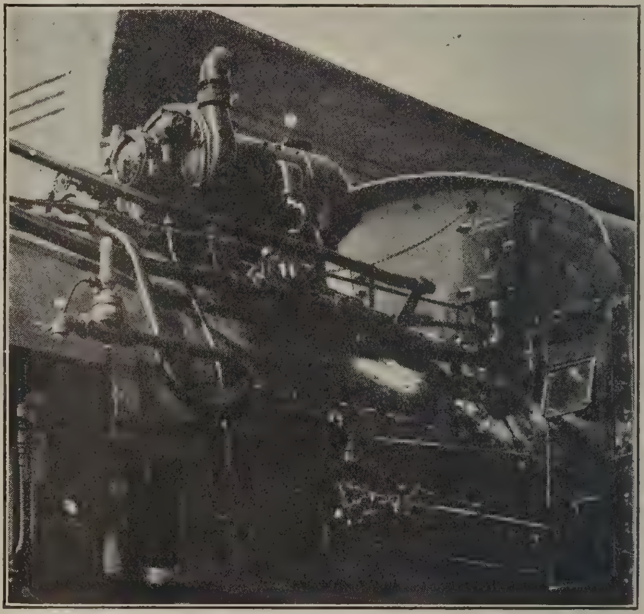
(b)—On account of size of train wires required, fittings should be of such design as to permit of easy application and maintenance. Fitting design must also be such as to give maximum protection to wires from deteriation due to heat, gas, weather, etc.

(c)—Conduit should be continuous from generator to point of flexible connection to train, except for short flexible connector between cab and tender.

(d)—Control of current supply to train should be by means of an approved safety switch, located preferably on back board of cab over firing aisle, and within easy reach of enginemen.

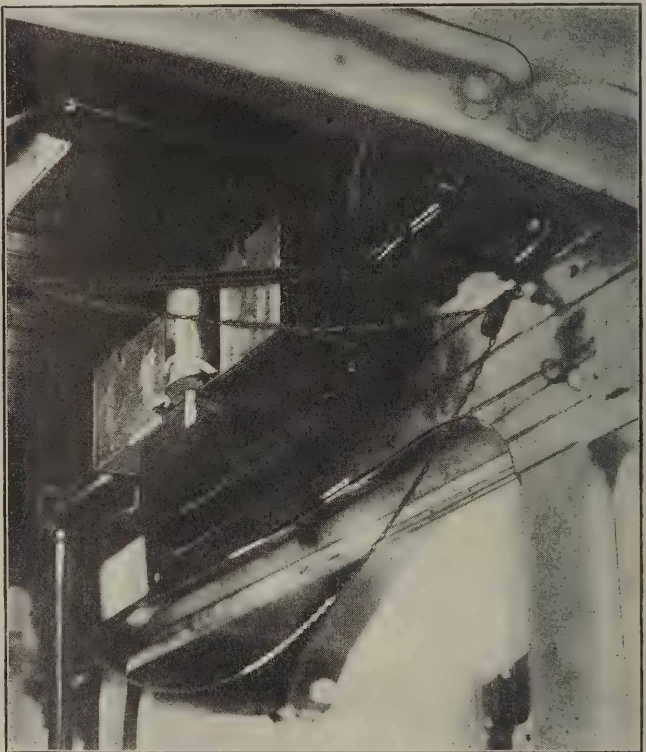
(e)—A train line terminal box of adequate design to meet service conditions should be applied on outside front wall of cab, to permit of disconnecting wires for removal of cab.

(f)—Suitable weatherproof outlets should be applied to ends of train-line conduit run, where generator leads center and flexible train connector leads leave conduit.



A Close-Up View of Turbo-Generator and Terminal Box Application

(g)—Suitable extra flexible cables should be used between cab and tender and locomotive and train. These cables should be of sufficient length to permit of trains passing over curves without fear of straining or breaking cable.



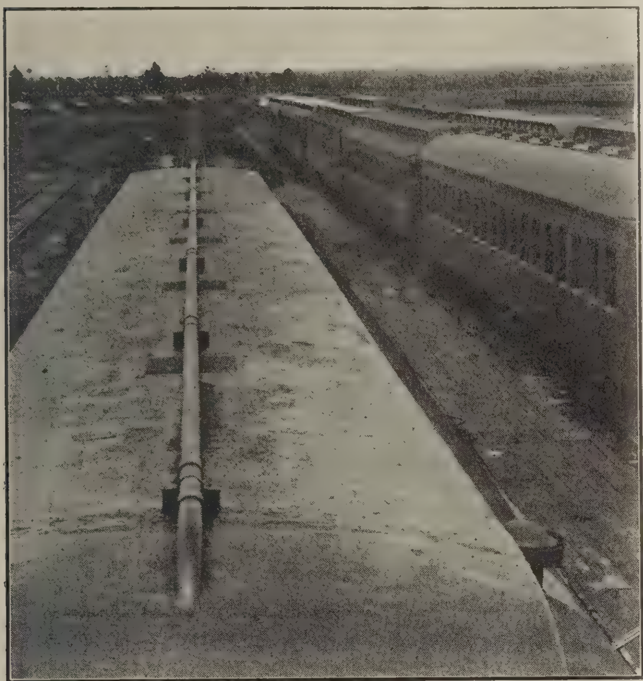
Showing Application of Conduit and Safety Switch to Cab

(h)—Dummy receptacles at front end of locomotives and at rear tenders should be mounted on the under side of a boiler plate, mounted on suitable bracket.

By the insertion of the train line plug of the flexible connec-

tion between engine and train as covered in Sec. G., into the dummy receptacle, when plug is not in use, a considerable amount of damage may be averted.

Conduit fitting for end of conduit run at this point, should be mounted on top of boiler plate.

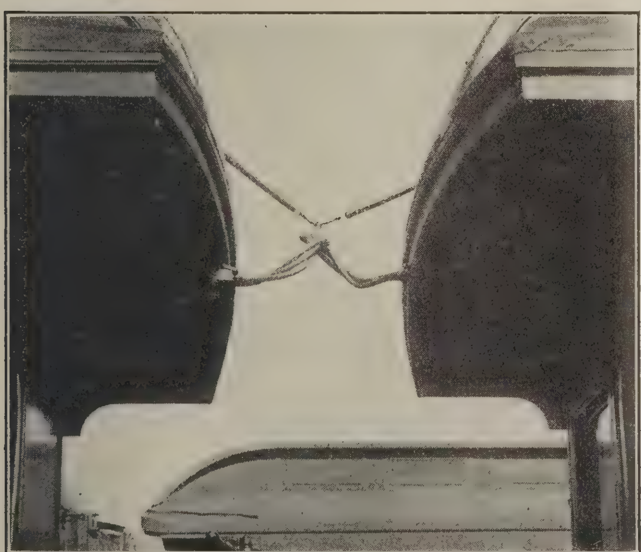


Showing Method of Applying Conduit to Car Roofs

(i)—All conduits should be securely clamped. This matter should receive special attention.

3—CARS—CONDUIT & WIRING

(A)—Every effort should be made to insure a proper light distribution. It is recommended where possible, that the standard spacing for through line coaches be adhered to. Suitable fixtures and shades adapted to the type of car to be lighted should be obtained, special attention being given to the general appearance of same.



Showing Method of Supporting the Train Line Connectors Between Cars

(B)—*Conduits.*

In the case of new equipment, conduit should be run on the interior of the car, but not exposed to view. However, in the case of old equipment such as might be used for branch line and suburban service, it is more economical and more desirable to apply the conduit to car roof. In such installations, the conduit may be in continuous lengths entering platform deck through an elbow, which will extend a sufficient distance inside deck to protect wires leading to train line receptacles. There may be instances where roof junction boxes may be necessary, but ordinarily, car circuit wires may be connected to train line wires inside of platform deck by means of a clamp, which may be applied to train line wires. This method creates a very great labor saving, and is as serviceable as necessary.

(C)—*Wiring.*

For the car circuit wiring, Wire Mold has been found very satisfactory, both from a cost standpoint, as well as from a labor-saving in application standpoint, together with its general appearance. Necessary fittings such as elbows, tees, junction boxes, outlet boxes, etc. are available when required. This moulding is attached to head-lining with small clamps and can be arranged for panel effect by the addition of wood moulding strips from the side of head-lining to center.

Fixtures used with this installation are a matter of choice.

It is recommended that the fixtures be either the railroad's standard for car-lighting service, or where efficiency and economy are prime requisites, the use of a deep bowl glass reflector with a simple design of fixture.

Interior View of Cars Showing Arrangement of Fixtures

The cut-out switch and fuses may be located in the saloon, and may be arranged for one or two circuits as required.

If service requirements call for the application of a storage battery auxiliary, a car circuit battery control panel, several types of which are available on the market, especially designed for Locomotive Train Lighting, may be mounted in saloon, or some other convenient place.

The following is a list of installations in which a turbo-generator of 5 kw. or greater capacity is used:

Railroad	No. of gen.	Gen. cap.	System train	Voltage loco.	Train line	No. of cars	Auxiliary
B. & M.	33	7½ kw.	32	32	3 wire	140	None.
B. R. B. & L.	2	5 kw.	115	115	2 wire	8	1 bat. per tr.
C. B. & Q.	39	7½ kw.	64	32	3 wire	198	None.
C. M. & St. P.	3	7½ kw.	64	32	3 wire	400	......
C. R. I. & P.	37	7½ kw.	64	32	3 wire	127	50 bat. 77 none.
C. & N. W.	3	7½ kw.	64	32	3 wire	33	None.
N. P.	9	7½ kw.	64	32	3 wire	30	None.
T. C. & I.	1	7½ kw.	64	32	3 wire	10	None.

The C. M. & St. P. also have approximately 1,100 locos. equipped with 1½ and 2½ kw. turbo-generators used in this service. These turbos. were originally purchased for head-lighting during the days of the arc lamp. It was later found that with the introduction of the incandescent lamp sufficient extra capacity was available to light two or three cars.

Your Committee presents this information, not as a recom-

mended standard practice, but rather as an assistance to those who may be contemplating this application. It is further hoped that from a study of the above, together with improvements which will come with the several installations that will be made, a standard practice form may be compiled.

It is recommended that the succeeding committee be instructed to further investigate the possibilities of Locomotive Train Lighting in the field of branch line and main line operation, inasmuch as it represents a modernization of the older type of so-called Head End Lighting, and in the modernization of the same, the locomotive train lighting system as it is being developed, holds some possibilities along this line, worthy of study.

Respectfully submitted,

COMMITTEE ON TRAIN LIGHTING

Report of Committee on Electric Welding and Heating

Numerous Photographs and Diagrams to be Added to Manual to Cover New Developments in the Art

Committee:—

F. H. Williams, Chairman, assistant test engineer, Canadian National; E. Wanamaker, electrical engineer, Chicago, Rock Island and Pacific; Ernest Lunn, electrical engineer, Pullman Company; A. M. Frazee, electrical engineer, Duluth, Missabe and Northern; C. E. Moring, electrical engineer, Southern Pacific; J. C. McElree, electrical engineer, Missouri Pacific; T. A. Johnson, electrical engineer, Central of Georgia.

TO THE MEMBERS:

In compliance with instructions your committee has gone further into the subject of heat treating, arc welding, and metallurgy and has prepared, subject to approval, additions to the welding manual and is submitting for your consideration to be included in the manual as addition to the present data the following:

Section 1—Arc welding

Chapter 2—Fabrication of Structural Steel by Arc Welding. Describing by illustrations and data the use of the arc in structural steel work, practical applications, preparations for the work, tests for the tensile strength and illustrations by sketches and photographs of the work in various stages of process and tests as carried out.

Section 6—Heat Treating

Chapter 1—Describing normalizing locomotive side, main rods, and similar parts and annealing low carbon steel forgings, iron draw-bars and similar parts (wrought iron).

Chapter 3—Describing carbonizing and case-hardening processes giving practical information as to process in carrying on this work and illustrating same with photographs.

Section 7—Metallurgy

Chapter 1—Describing the metallurgy of iron and steel (with reference to welding and heat treating) illustrating with photographs.

Chapter 2—The metallurgy of electric arc welding (in mild steel) describing these processes and illustrating with photographs.

Chapter 3—The metallurgy of heat treating describing this process and illustrating with photos.

Chapter 4—The metallurgy of non-ferrous metals describing this process and illustrating with photographs.

The secretary-treasurer informed us that the printing of this addition to the manual on welding, on account of the many cuts that will have to be made from the photographs and drawings will cost approximately $600.

Action to be taken

Your committee recommends that the above described addition to the welding manual be accepted and authority for the above expenditure be granted and that the proposed addition to this manual be turned over to the committee on looseleaf manual to be put in proper form for printing.

Respectfully submitted,

COMMITTEE ON ELECTRIC WELDING AND HEATING.

Report of Committee on Manual

Uniform and Standard Forms for the Preparation of Committee Reports Will Greatly Assist Those Editing Reports for Manual

Committee:—

L. S. Billau, Chairman, assistant electrical engineer, Baltimore & Ohio; J. A. Andreucetti, assistant electrical engineer, Chicago and Northwestern; G. H. Caley, electrical and signal engineer, New York, Ontario and Western.

TO THE MEMBERS:

Your Committee respectfully submits its report on the following subjects:

1st—Completion of the first edition of the Manual of the Association of Railway Electrical Engineers.

2nd—Method of procedure for revising the Manual annually to keep it up-to-date.

3rd—Standardization of the form of committee reports.

Action recommended

Your Committee recommends the following action be taken on these subjects:

1st—That the recommended method of procedure for annually revising the Manual be adopted by the Association.

2nd—That a standard form for committee reports be adopted by the Association, and that the Committee on Manual in conjunction with the Executive Committee develop the details of these instructions which will be sent to each chairman by the Secretary along with the instructions for the work of the committees.

Recommendation for future work

The future work of the Committee will be confined to the routine work of revising and editing the Manual and carrying out such specific matters as may be referred to this Committee.

1. *Completion of First Edition of the Manual.*

The first or 1926 edition of the Manual of the Association of Railway Electrical Engineers has recently been distributed to the members. As you have been advised by letter from the Secretary, the Executive Committee has decided upon the following plan for the distribution of the Manual.

(a) Each member will receive a complete set of sheets comprising the Manual as well as revised and additional sheets that will be issued each year.

(b) The loose leaf binder for the Manual will be sold to members and non-members at a price of $1.50 and can be obtained from the Secretary.

(c) Sheets for the Manual will be sold to non-members at a price of 10 cents each, except certain sections of the Manual which will be issued as complete units and sold at prices to be established by the Executive Committee.

2. *Method for Annual Revision of the Manual.*

The revisions and additions to the Manual are the function of the various standing and special committees, the duty of the Committee on Manual being limited to the editing of the subject matter that has been decided should be incorporated in the Manual.

Each committee shall include as a part of its annual report a section entitled "Revision of Manual" which shall cover the following:

(a) What changes, if any, should be made in the subject matter already published in the Manual pertaining to the work of the Committee in question?

(b) What obsolete matter should be withdrawn?

(c) What new matter, if any, should be inserted in the Manual?

If the work of a committee is of such character that it has nothing to present that should be inserted in the Manual, it should so state in its report.

After the report of the committee has been acted upon the section covering recommendations for the Manual and action taken on it will be reviewed by the Executive Committee. If approved, they will be referred to the Committee on Manual for handling in connection with the annual revision of the Manual. If the Executive Committee considers that the matter should receive further consideration, it will be referred back to its committee for further action and presented at the next anuual meeting.

3. *Standardization of the Form of Committee Reports.*

It is felt that a standard and uniform form for the preparation of committee reports will greatly aid the work of the Committee on Manual, reduce the amount of editing necessary, etc. It will also be of assistance as well as benefit to the Association in taking action on committee reports when presented at the annual meetings. In this connection following form is suggested:

1st—List by items the subjects covered by the report, the first to consist of "Revision of Manual" as described in this report.

2nd—Action recommended to be taken on each of the subjects. For new subject matter this would cover (a) insertion in the Manual, (b) accepted as information, or (c) accepted as a progress report.

3rd—Recommendations for further work of the committee.

4th—The body of the report, each of the subjects covered being treated separately.

Respectfully submitted,

COMMITTEE ON MANUAL.

Report of Committee on Automatic Train Control

Information Is Both Given and Sought Regarding the Subject Upon Which Much Attention Is Focused at the Present Time

Committee:

F. E. Starkweather, Chairman, electrical engineer, Pere Marquette; Roy Liston, mechanical inspector, Atchison, Topeka & Santa Fe; F. L. Rutledge, supervisor locomotive electric equipment, New York Central; C. G. Winslow, asst. electrical engineer, Michigan Central; A. G. Mueller, supervisor automatic train control, Chicago, Rock Island & Pacific.

TO THE MEMBERS:

Your Committee has held meetings during the year and has the following suggestions and information to submit:

Power Supply

Energy for a Train Control system is obtained in the majority of types in service, from headlight turbo generators.

The load of the majority of types of Train Control systems in service is from eighty (80) to one hundred and fifty (150) watts.

The recommended voltage that should be maintained, assuming that a thirty-two (32) volt turbo-generator is employed, is from thirty-one and one-half (31½) to thirty-three and one half (33½) volts, taking into consideration that a one and five-tenths (1.5) volt drop from a turbo to Train Control mechanism. This will insure the best operation and maintenance, although a number of different types of Train Control will operate satisfactorily on a greater variation in turbo voltage.

The governor valve of the turbo should be given the proper maintenance to insure that the voltage can be maintained between the limits mentioned above, it being particularly necessary in sections where the locomotive water supply is not of the best. To prevent incrustation, it is suggested that once or twice a week, a small quantity of valve oil be put into the steam pipe leading to the valve. To do this a "Tee" should be placed in the steam pipe and oil inserted at this point while the turbo throttle is closed.

While grounds in the headlight wiring may not prevent the proper operation of Train Control apparatus, such grounds are a potential source of future trouble. A combination of grounds might give serious trouble. Therefore, it is strongly recommended that headlight wiring be kept entirely free from grounds.

Inspection

Complete inspection should be made of all train control apparatus each time engine arrives at terminal. This inspection should include check of all operating characteristics in such manner to disclose grounds, opens or shorts in circuits; leakage of air, restricted pipes or ports and complete functioning of each electric and pneumatic unit.

Test Equipment

Test apparatus should be provided and maintained to facilitate test and inspection.

Records

Records of condition and functioning of equipment should be maintained on suitable forms so that comprehensive analysis of performance can be readily made.

Maintenance

Conduit systems should be maintained in good condition. All conduit should be kept tightly fastened to its supports and free from any accumulation of coal or dirt. The drainage holes should be periodically inspected to see that they are keeping the interior of the conduit free from the accumulation of water.

All wire connections should be inspected periodically. Also, see that nuts on binding posts are properly tightened and locked and that the wire leads away from the binding post in the proper manner, with sufficient slack to prevent any strain on the binding post.

Other electrical parts should be inspected periodically, cleaned thoroughly and worn or defective parts replaced.

Pneumatic parts should be inspected and cleaned regularly in a manner similar to standard practice for air brake equipment.

QUESTIONS AND ANSWERS OF TRAIN CONTROL EQUIPMENT

Question: *What is the Actuator?*

Answer: The Actuator is an air-operated differential piston and mechanism mounted on the automatic brake valve. Its purpose is to move the rotary valve to the service position automatically.

Question: *What is an E. P. Valve?*

Answer: An E. P. Valve is an electrically-operated air valve used to control the operation of the actuator.

Question: *What is the Whistle Valve?*

Answer: The whistle valve is an electrically-operated air valve used to sound a whistle.

Question: *What is a Receiver?*

Answer: A Receiver is a two pole electro-magnet which is mounted on the locomotive. Its purpose is to react on the engine electrical apparatus, the caution or stop indications, displayed by fixed signals.

Question: *What is an Inductor?*

Answer: An inductor is an iron core wound with wire and enclosed in a non-magnetic housing which is generally mounted on ties adjacent to the running rail. The purpose of the in-

ductor is to react on the engine electrical apparatus by means of the receiver, the caution or stop indications, displayed by fixed roadway signals.

Question: *What is a Ballast Lamp?*

Answer: Ballast Lamps or Resistors used in Train Control systems are of a lamp type, having in most cases standard S-17 bulbs with medium screw bases. The filament of the lamp is iron wire and the bulbs are filled with hydrogen gas, and their use is to maintain a constant current to the train control apparatus during fluctuations in turbo-generator voltage.

TYPES OF TRAIN CONTROL IN SERVICE

Final Inspection of Automatic Train Control Installations By Interstate Commerce Commission. First Order

C. R. I. & P.	November 19-30, 1923	Regan	Ramp.
C. & E. I.	January 6-20, 1925	Miller	Ramp.
O. W. R. R. & N.	March 24-April 10, 1925	Union	Two-Speed
G. H. & S. A.	July 13-25, 1925	National	Intermittent Induction
S. P.	July 30-Aug. 12, 1925	National	Intermittent Induction
St. L.-S. F.	Aug. 3-15, 1925	National	Intermittent Induction
*C. & O.	Aug. 24-Sept. 19, 1925	American	Ramp.
N. & W.	Sept. 8-Oct. 10, 1925	Union	Three-Speed
C. B. & Q.	Sept. 22-Oct. 19, 1925	Sprague	Intermittent Induction
U. P.	Oct. 7-Nov. 7, 1925	Union	Two-Speed
G. N.	Oct. 28-Nov. 19, 1925	Sprague	Intermittent
M. P.	Jan. 12-Feb. 4, 1926	National	Intermittent Induction
Reading	Jan. 12-Feb. 6, 1926	Union	Three-Speed Continuous
C. R. R. of N. J.	Jan. 18-Feb. 13, 1926	Union	Three-Speed Continuous
A. T. & S. F.	Jan. 18-Feb. 24, 1926	Union	Three-Speed Continuous
A. C. L.	Mar. 3-Mar. 25, 1926	General	Auto-Manual
L. & N.	Mar. 3-Apr. 2, 1926	Union	Two-Speed Continuous
N. P.	Mar. 12-Mar. 27, 1926	Sprague	Intermittent
C. M. & St. P.	Mar. 29-Apr. 17, 1926	Union	Continuous Stop
P. M.	April 16, 1926	General	Auto-Manual
D. L. & W.	April 27, 1926	Union	Two-Speed
I. C.	April 22-May 14, 1926	Union	Continuous-Stop
C. & N. W.	May 4	General	Two-Speed

* Original ramp installation. No report issued to date. I. C. C. reports issued on all above inspections—except: P. M.—C. & N. W.

STATUS FOR JULY, 1926—SECOND ORDER

Permanent Installations Completed or in Service

B. & A.	Boston to Springfield, Mass.	General—Auto Manual	258.5
C. B. & Q.	Pacific Jct., Ia., to Lincoln, Neb.	Sprague-Intermittent	99.5
C. N. O. & T. P.	Somerset, Ky. to Chattanooga, Tenn.	General—Auto Manual	257.7
C. C. C. & St. L.	Mattoon to Lanox, Ill.	General—Auto Manual	181.1
G. N.	New Rockford to Minot, N. D.	Sprague-Intermittent	113.4
*I. C.	Waterloo to Ft. Dodge, Ia.	Union—Stop	98.5
M. C.	Jackson to Niles, Mich.	General—Auto Manual	233.0
P. M.	Lansing to Detroit, Mich.	General—Auto Manual	78.49
N. Y. C.	Cleveland, O. to Buffalo, N. Y.	General—Auto Manual	702.5
N. P.	Dickinson, N. D. to Glendive, Mont.	Sprague—Intermittent	106.0
Southern	Greenville, S. C. to Atlanta, Ga.	General—Auto Manual	306.8
S. P.	Tracy to Fresno, Calif.	National—Intermittent	125.4
U. P.	North Platte to Sidney, Neb.	Union—Two Speed	248.0

Permanent Installations Under Construction

A. T. & S. F.	Chicago to Chillicothe, Ill.	Union—Three Speed	248.0
B. & O.	Baltimore, Md. to Philadelphia, Pa.	General—Auto Manual	185.0
C. & O.	Staunton to Clifton Forge, Va.	Union—Intermittent	55.0
C. & N. W.	Clinton to Boone, Ia.	General—Two Speed	414.0
C. R. I. & P.	Davenport to Des Moines, Ia.	Regan—Ramp	243.7
G. H. & S. A.	Glidden to San Antonio, Texas	National—Intermittent	123.0
L. & N.	Mobile, Ala., to New Orleans, La.	Union—Stop	139.0
Penn.	Harrisburg to Altoona, Pa.	Union—Stop	479.0
P. C. C. & St. L.	Pittsburgh, Pa., to Newark, Ohio	Union—Stop	313.98
St. L.-S. F.	Monett, Mo. to Afton, Okla.	National—Intermittent	71.0

Territory Selected

A. C. L.	South Rocky Mount, N. C. to Florence, S. C.	344.2
C. R. R. N. J.	Elizabeth to Bay Head, N. J.	49.7
C. & E. I.	Danville, Ill. to Clinton, Ind.	77.4
C. M. & St. P.	LaCrosse to Portage, Wis.	206.1
C. I. & L.	Monon to Indianapolis, Ind.	
D. & H.	Albany to Whitehall, N. Y.	154.0
L. V.	Easton to Sayre, Pa.	484.58
L. I.	Jamaica to Babylon, L. I.	55.2
N. Y. N. H. & H.	New Haven, Conn. to Providence, R. I.	226.0
N. & W.	Roanoke, Va. to Shenandoah, Va.	132.6
Reading	Bethlehem to Jenkintown, Pa.	

Devices Selected by Carriers in Second Order

General Railway Signal Company.
- INTERMITTENT:
- Baltimore & Ohio.
- Boston & Albany
- Cincinnati, New Orleans & Texas Pacific.
- Cleveland, Cincinnati, Chicago & St. Louis.
- Michigan Central
- New York Central
- Pere Marquette*
- Southern
- TWO SPEED CONTINUOUS:
- Chicago & North Western

Miller Train Control Corporation.
- Chicago & Eastern Illinois

National Safety Appliance Company.
- Galveston, Harrisburg & San Antonio
- St. Louis-San Francisco
- Southern Pacific

Regan Safety Devices Company.
- Chicago, Rock Island & Pacific

Sprague Safety Control & Signal Corporation.
- Chicago, Burlington & Quincy
- Great Northern
- Northern Pacific

Union Switch & Signal Company.
- TWO SPEED:
- Union Pacific
- THREE SPEED:
- Atchison, Topeka & Santa Fe
- STOP:
- Illinois Central
- Louisville & Nashville
- Pennsylvania
- Pittsburg, Cincinnati, Chicago & St. Louis
- INTERMITTENT:
- Chesapeake & Ohio

Selection Not Announced.

Atlantic Coast Line, Central Railroad of New Jersey, Chicago, Indianapolis & Louisville, Chicago, Milwaukee & St. Paul, Delaware & Hudson, Delaware, Lackawanna & Western, Erie, Lehigh Valley, Long Island, New York, New Haven & Hartford, Norfolk & Western, Reading.

Date of Completion Suspended Until Further Order of Commission.

Boston & Maine, Missouri Pacific, Chicago & Alton, New York, Chicago & St. Louis.

Exempted.

Buffalo, Rochester & Pittsburgh, Chicago & Erie, Chicago, St. Paul, Minneapolis & Omaha, Kansas City Southern, Oregon-Washington Railroad & Navigation Company, Pittsburgh & Lake Erie, Western Maryland.

No Decision Announced—D. L. & W., Erie.

Exempt

Buffalo, Rochester & Pittsburg, Chicago & Erie, Chicago, St. Paul, Minneapolis & Omaha, Kansas City Southern, Oregon-Washington Railroad & Navigation Company, Pittsburgh & Lake Erie, Western Maryland.

Date of Completion Suspended Until Further Order

Boston & Maine, Missouri Pacific, New York, Chicago & St. Louis, Chicago & Alton.

*Single track operation without intermediate wayside signals.

FINAL INSPECTIONS OF AUTOMATIC TRAIN CONTROL INSTALLATIONS BY INTERSTATE COMMERCE COMMISSION SECOND ORDER

P. M.	April 16	General	Auto-Manual
I. C.	May 17-June 3, 1926	Union	Continuous Stop
U. P.	July 8	Union	Two-Speed Cont.
S. P.	July 12	National	Int. Induction
D & H.	July 27	General	Auto-Manual

I. C. C. reports not yet issued on the above inspections.

Roads Upon Which Train Control Installation to Comply with I. C. C. Orders Was Completed July 18, 1926

Road	First order: Miles of track	First order: Engines	Second order: Miles of track	Second order: Engines
A. T. & S. F.	203.97	87	....	*
A. C. L.	239.0	55	....	...
B.& O.	69.2	130	....	...
B & A.	234.5	202	258.5	*
B. & M.				
C. R. R. N. J.	65.6	30	....	...
C. & O.				
C. & A.				
C. & E. I.	210.8	138	....	...
C. & N. W.	298.0	122	....	...
C. B. & Q.	139.8	58	99.5	39
C. I. & L.	67.7	32	....	...
C. M. & St. P.	216.2	58	....	...
C. R. I. & P.	330.8	105	....	...
C. N. O. & T. P.	235.0	95	257.7	63
C. C. C. & St. L.	200.8	72	181.1	15x
D. & H.	118.3	60	....	...
D. L. & W.	282.0	69	....	...
Erie				
G. H.& S. A.	50.7	38	....	...
G. N.	142.57	35	113.4	24
I. C.	243.6	56	98.3	38
L. V.	175.02	150	....	...
L. I.				
L. & N.	162.0	47	....	...
M. C.	149.0	170	233.0	*
M. P.	50.0	39	S	S
N. Y. C.	553.11	444	702.5	375
N. Y. C. & St. L.	154.85	45	S	S
N. Y. N. H. & H.	119.6	60	....	...
N. & W.	106.1	41	....	...
N. P.	109.6	35	....	...
O. W. R. R. & N.	86.1	33	E	E
Pa.	166.21	162	....	...
P. M.	60.9	65	78.49	*
P. C. C. & St. L.				
P. & L. E.	227.68	103	E	E
Reading	113.0	50	....	...
R. F. & P.				
St. L.-S. F.	44.4	40	....	...
S. P.	100.1	125	125.4	75
Southern	308.0	65	306.8	35
U. P.	204.0	99	248.0	31
W. J. & S.				
Total	6,238.21	3,215	2,702.69	695

S—Order Suspended.
E—Exempt.
...—Second Order not completed on above date.
*—Included under First Order.
x—In addition to First Order.

Additional Experimental Installations Not Included in Either Order

Clark System:

Installed and tests being conducted on 20 miles of track on Michigan Central Railroad between Jackson and Rives Junction having 10 equipped engines. On July 13, a test was made by the proprietors in presence of railroad representatives.

Miller Train Control Corporation:

* * *

Installed on 28 miles of track on New York Central Railroad between Air Line Junction and Monroe on the Detroit branch with 10 equipped engines. 34 inductors are in operation on the roadway and 12 test inductors in service at engine terminals. 97 additional track inductors ordered for installation upon that part of the division not already equipped.

* * *

Regan Safety Devices Company:

An experimental installation of this Company's intermittent induction system of automatic train control, including speed control, is made on the Buffalo Division of the Erie Railroad between Attica and Depew, N. Y., 22 miles.

Webb Device:

The test of the Webb ramp type train control device is being continued on the Northern Division of the Erie Railroad.

* * *

Your Committee would like to hear a discussion on the floor of the following subjects:

No. 1.—What effect has train line leakage with Train Control applications?

No. 2. Is a split reduction effective in producing a smooth stop with automatic air operation?

No. 3.—What advantage has saturated steam supply to turbo generators over super-heated steam?

Action Recommended

Acceptance as Information.

Respectfully submitted,

COMMITTEE ON AUTOMATIC TRAIN CONTROL

Report of Committee on Self-Propelled Vehicles

Instruction Books Covering the Details of Maintenance on Rail Motor Cars Essential to Proper Care of Equipment

Committee:

R. G. Gage, chairman, electrical engineer Canadian National; E. Wanamaker, electrical engineer, Chicago, Rock Island & Pacific; T. A. Johnson, electrical engineer, Central Railway of Georgia; L. L. King, electrical engineer, Atchison, Topeka & Santa Fe; E. S. M. Macnab, engineer car lighting, Canadian Pacific; J. C. McElree, electrical engineer, Missouri Pacific; F. G. Baker, electrical engineer, St. Louis & San Francisco.

TO THE MEMBERS:

Your Committee on Self-propelled Cars is composed of representatives from railways that are separated almost as far as possible from each other. This fact, together with what would appear to have been a very busy year for all, has made it very difficult to secure fully attended meetings. There have been, however, several small meetings held in Chicago, at which all phases of our subject were given consideration.

Being unanimous in the recognition of the importance of having well defined and concise instructions covering the maintenance and operation of unit rail cars, which are still to the great proportion of steam railway operating men, a new type of equipment, it was thought that our committee could not be of greater usefulness than by starting this work. Arrangements were, therefore, made with the Electromotive Company of Cleveland, that they and their affiliated companies should prepare an instruction book covering the electrical, mechanical and structural features, together with the operation and maintenance of the Electromotive gasoline-electric car.

Members of this committee have collaborated with the manufacturers in editing this instruction book, and it is your committee's recommendation, and the association is hereby requested to authorize it to be printed and to be issued as recommended practice of the association.

The following are the headings of the chapters as contained in the "Contents," from which can be seen the general scope and magnitude of the work.

INTRODUCTION

Chapter 1—Engine—General Details.
Lubrication.
Operation.
2—Carburetor.
3—Magneto.
4—Generator and Exciter.
5—Battery Charging Panel.
6—Throttle Control (P. S.—15-B Switch, Air Starter Valve, Throttle Arrangement).
7—Batteries (Details of Battery Method of Battery Charging).
8—Gasoline Fuel System.
9—Cooling System.
10—Air Compressor and Governor.
11—Air Brake System.
12—Traction Motors.
13—T r u c k s—Wheels—Brakes—Shoes—Motors—Side Bearings—Center Pins.
14—Controller.
15—Signals—Bell—Whistle.
16—Accessories, Switches, Cutouts, Fuses, etc.
17—Lubrication—General.
18—Operation—General.
19—Service and Repairs.
20—Questions and Answers.
21—Appendix—
A. Electricity.
B. Gasoline Engines.

Inasmuch as this particular car is the most generally used of the gasoline-electric type, at the present time on the American railways, your committee has worked with the Electromotive Company as the first step in its effort to have prepared and issued similar instructions for all gasoline-electric cars. This same work must be done for gasoline-mechanical cars and also on Diesel-electric. The first of these have the longest record of any motor cars on our railways and are, therefore, best understood, while the Diesel-electric is perhaps the least understood, and, so far, has been used to any degree only by one company. It has, however, been found on this railway that a proper book of instructions on the Diesel-electric equipment is very essential for the satisfactory operation and maintenance of these cars, and such a book has already been prepared.

In making this recommendation your committee has been governed by the experience of several railways in the actual operation and maintenance of rail car equipment, and is offering a work which it feels will be of very definite usefulness to all those in any way connected with the operation or maintenance of the Electromotive Company's gasoline-electric rail cars.

A typewritten copy of the instruction book is available at this meeting for your inspection.

Respectfully submitted,

COMMITTEE ON SELF-PROPELLED VEHICLES.

Report of Committee on Locomotive Lighting

Owing to the Experimental Stage of Certain Phases of the Subject Definite Recommendation Cannot Yet Be Made

Committee:

L. C. Muelheim, chairman, chief headlight supervisor, Baltimore & Ohio; J. L. Minick, assistant engineer, Pennsylvania System; O. W. Sparker, district supervisor of locomotive electric equipment, New York Central; F. J. Hill, chief electrician, Michigan Central; Joseph A. Cooper, assistant electrical engineer, Wabash Railway.

TO THE MEMBERS:

The report of your committee at this time is more or less a progress report, owing to inability to make final recommendations on certain of the subjects being handled, due to the rapid change in design and development of locomotive electrical equipment.

Capacity of Turbo-Generator

At last year's meeting a lengthy discussion occurred on the question of turbo-generator capacity in connection with operation of automatic train control, the recommendation of a generator of not less than 750 watts being considered premature in view

of the limited amount of experience at that time with requirements of train control equipment. Development since that time would indicate that a generator at least of a larger capacity than the 500 watt generator commonly used for locomotive lighting will be necessary for practical and reliable service. Present indications, also, are that in addition to the lighting and train control requirements of the generator that other accessories of the locomotive will be electrically operated, possibly in the near future, and with a natural increase in electrically operated devices a growing demand on the generator will result. Its capacity therefore should be such as to anticipate future demands as nearly as possible, and at this time it would appear that the minimum previously suggested by your committee was conservative and could possibly have been considerably higher with good reason. A definite recommendation, however, as to generator capacity should receive further study in view of present developments before conclusion is reached in the matter of complete specifications for a generating unit. It is suggested, therefore, that your committee continue this subject, pursuing the study of its various phases somewhat further during the present period of development and until the situation will permit of more crystalized views.

Photometry of Headlight Reflectors

The study of photometry of headlight reflectors is still being carried out, considerable laboratory experiment being conducted in the investigation of this matter, but additional work of a similar nature will be necessary to carry the investigation to the point where a standard method can be definitely recommended. The matter should, therefore, be continued, as it is expected that the study which has been under way will be completed in the near future, and that a final report on the results will be possible at the next meeting of the association.

Lamps for Locomotive Lighting Service

In the report of the Committee on Illumination important development since last year and the status regarding lamps for locomotive lighting is thoroughly covered. In view of the experience obtained from extensive use of the S-14 bulb cab lamp on some of the railroads it would appear that this lamp should have had a more general trial as an improvement over the S-17 bulb than has been the case. It is the recommendation of your committee, therefore, in view of the advantages of the smaller lamp, that those roads which have not changed from the S-17 bulb give due consideration to the new lamp and arrange to make a thorough and early trial to determine the matter of its general adoption.

The 100 watt, P-25, inside frosted bulb headlight lamp is being tried out on a small scale for switching locomotive service as a result of a request for this type of lamp to overcome the objection to the clear bulb of identical construction as that of the 250 watt lamp. Visibility tests with the frosted bulb have been made on two railroads with almost identical results, the pick-up distance obtained in one series of tests averaging 332 feet and in the other series 344 feet. In both tests the visibility conditions were decidedly adverse, and the results were considered highly favorable to the lamp. The objectionable glare, typical of the clear bulb lamp, was entirely absent, while a wide diffusion of light in front of the locomotive was noted as being very desirable for general illumination. While the pick-up distances obtained in these tests may not appear to provide a sufficient margin over the required distance for switching service it should be appreciated that adverse conditions prevailed during the tests. However, should it be desirable to obtain a higher efficiency, should this type of lamp ultimately become a standard lamp for switching locomotives, it is understood that the lamp manufacturers can readily increase the wattage slightly to a value which will assure the required distance.

A few lamps of this type are being tried out in regular yard service, and as a supply will be commercially available from the manufacturers for trial your committee recommends that the roads secure and try out a sufficient number of these lamps to determine from actual experience whether or not this type is the propert solution to the problem of headlight lamp for switching locomotive service.

The 100 watt lamp in A-21 clear bulb for switching locomotive headlights, which is the latest proposal for differentiating between the road locomotive and switching locomotive lamp in similar bulbs, is too highly experimental at this time to permit of more than passing mention. It will also be appreciated that this lamp having a clear bulb would still retain the objectionable feature of glare, which is well overcome in the lamp with inside frosted bulb.

Respectfully submitted,

COMMITTEE ON LOCOMOTIVE LIGHTING.

An Electrified Line in the Bavarian Mountains

E. A. LUNDY
E. A. Lundy Co.
President

W. H. FENLEY
Kerite Insulated Wire and Cable Co.
Senior Vice President

CHAS. DUBSKY
Crouse-Hinds Co.
Chairman Exhibit Committee

EDWARD WRAY
Railway Purchases and Stores
Secretary and Treasurer

Exhibits of the Supply Manufacturers

Enlarged Space Provided Is Completely Filled By Sixty Exhibitors

THE Railway Electrical Supply Manufacturers Association, with a total of 63 company memberships, will have 60 companies showing exhibits at the 16th annual convention of the Association of Railway Electrical Engineers. The location of the exhibits as last year will be in the Hotel Sherman, Chicago, Ill. Meetings of the Association of Railway Electrical Engineers will be held in the grand ballroom. The meeting room, the exhibits and the registration booth are located on the mezzanine floor as shown in the accompanying diagram. The dates of the convention are October 26, 27, 28 and 29.

Exhibit Directory

The following is an alphabetical list of the manufacturers having exhibits at the convention and includes the exhibit space number (see diagram) with a brief description of the products shown and the names of the representatives present.

Adams & Westlake Company, Chicago, Ill.—Spaces No. 25, 26 and 27.—Electric fixtures for Pullmans, diners, coaches, club cars, railway mail cars; paddle fans; cast aluminum electric signal lamps; crossing signals. Represented by A. S. Anderson, W. J. Pierson, H. G. Turney, W. G. Porter, E. Andrews, R. D. John, J. M. Willits, F. W. Foehringer, J. N. Black.

Ahlberg Bearing Company, Chicago, Ill.—Space No. 53.—CJB Master ball bearings; Ahlberg ground bearings. Represented by W. O. Bender, F. O. Burkholder, B. B. Clark, H. E. Dunning.

Albert & J. M. Anderson Mfg. Co., Boston, Mass. —Space No. 35½.

Allen Bradley Company, Chicago, Ill.—Space No. 79-A.

Appleton Electric Company, Chicago, Ill.—Spaces No. 51 and 52.—Unilets; steel conduit fittings; reelites; the latter being automatic take-up reels for electrical conductors. Represented by E. A. Hakanson, J. T. McHenry, A. F. Hakanson, A. S. Merrill, E. G. K. Anderson.

The Baker-Raulang Company, Cleveland, Ohio.—Space No. 12.—Locomotive type crane truck; three-wheel tractor; elevating platform truck; Hy-lift truck. Represented by M. A. Watterson, F. N. Phelps, W. F. Hebard, T. W. Barnes, H. B. Greig, W. I. Lott, V. A. Shouldis.

Benjamin Electric Mfg. Co., Chicago, Ill.—Space No. 37.—Lighting equipment for railways; demonstrations of equipment; pictures of lighting installations. Represented by J. T. B. Addington, R. C. Mons, A. H. Wiese.

J. G. Brill Company, Philadelphia, Pa.—Space No. 80-A.

The Bryant Electric Company, Bridgeport, Conn.—Space No. 76-A.—Electrical wiring devices. Represented by J. W. Thomas, W. O. Dahlstrom, W. H. Rush, C. E. Roberts, C. W. Foster, W. A. Stacey.

The Buda Company, Chicago, Ill.—Space No. 28.—Buda-Ross turbo generator sets, Model GW, Design "C" and Model 900 T. C. especially designed for locomotive headlighting and train control service. Represented by M. A. Ross, T. H. Williams, H. P. Bayley.

Bussman Mfg. Co., St. Louis, Mo.—Space No. 4.—Complete line of Buss fuses including all types of renewable, non-renewable, plug and cartridge fuses, open fuses, auto fuses, fuse wire, etc. Represented by M. J. Wolf, J. C. Ingram, D. E. Spear, Jr., G. T. Perlick.

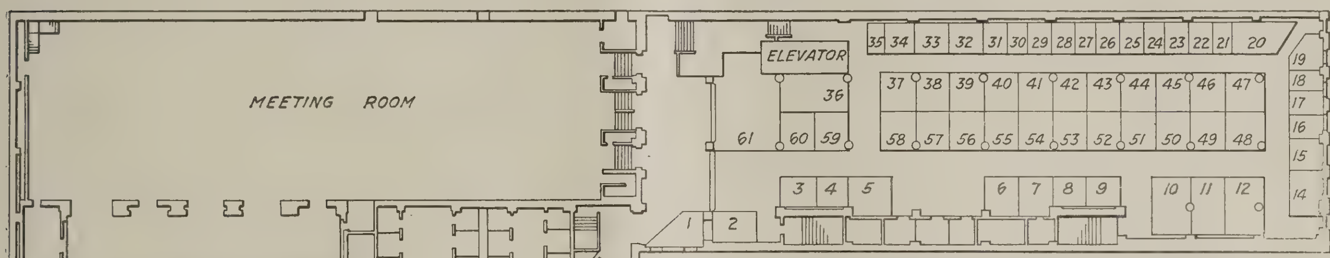
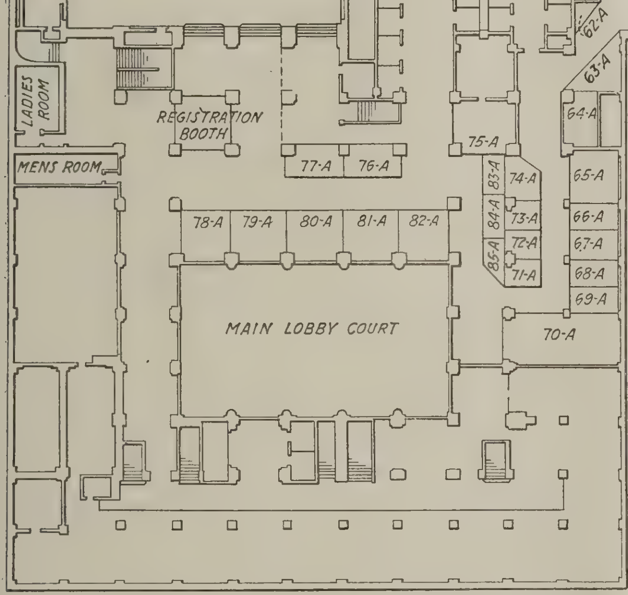
Central States General Electric Supply Company, Chicago, Ill.—Space No. 61.—Attalite luminaires; Maxolite reflectors; Ralco line of receptacles; plugs and locomotive devices; Maxocord; Mastercord; railway type fans; locomotive wire; Gibbs connectors; locomotive cab cords; V. R. marker plug and other devices designed for steam railroads; general wiring devices. Represented by R. C. Close, W. H. East, G. Jerome, J. M. Lorenz, A. G. Smith.

Chicago Fuse Mfg. Co., Chicago, Ill.—Space No. 38.—Union renewable fuses; Union and Gem non-renewable fuses; Gem plug and radio fuses; Union outlet boxes and Gem sectional switch boxes. Represented by A. E. Tregenza, E. J. Hamilton, L. C. Noyes, H. P. Collins.

Crouse-Hinds Company, Syracuse, N. Y.—Spaces No. 19, 20, 21 and 22.—Condulets; railroad electrical fittings; floodlights; safety switches; panelboards. Represented by R. Olley, F. C. Smith, H. J. MacIntyre, A. B. McChesney, F. F. Skeel, Charles Dubsky, W. W. Booth, E. F. Granzow, N. E. Bigley, G. G. Griffin.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.—Space No. 10.—C-H red top lifting magnet; A. C. across-the-line automatic starters; battery charging equipment; new C-H electrical space heater. Represented by C. J. Maloney, K. O. Swanson, A. H. James.

Economy Fuse & Mfg. Co., Chicago, Ill.—Space No.

Location and Arrangement of Exhibit Booths

77-A.—Economy renewable cartridge enclosed fuses; Eco non-renewable non-indicating enclosed cartridge fuses; Arkless indicating non-renewable enclosed cartridge fuses; Economy renewable plug fuses; Clearsite non-renewable plug fuses. Represented by R. S. Smith.

Edison Storage Battery Company, Orange, N. J.—Space No. 3.—Edison batteries for car lighting service; Edison batteries used in industrial truck and tractor service. Represented by D. C. Wilson, W. F. Bauer, L. C. Hensel, A. M. Andersen, U. V. McMillian, D. B. Mugan, J. L. Hays, O. A. Neidermeyer.

Electric Service Supplies Company, Philadelphia, Pa.—Spaces No. 65-A, 66-A, 67-A.—Golden Glow headlights; Keystone turbo generators; switches; Golden Glow floodlights. Represented by C. J. Mayer, H. G. Graham, H. D. Rohman, E. B. Hallman, J. W. Porter, T. M. Childs, B. D. Barger, J. F. Carper.

The Electric Storage Battery Company, Philadelphia, Pa.—Spaces No. 14 and 15.—Standard E. S. B. car lighting equipment including distributing panel, control panel and type D-3 generator; two cell EP-13 car lighting battery cut away at corner to show Manchester Positive and Box Negative plates; two cell type MVAH-17 battery with pasted plates also cut away to show construction; single unsealed cell of same type but with iron clad positive plates; Exide car lighting battery in KXK-11 cell; Exide bus lighting battery type KXK; signal batteries, paintings depicting railroad activity. Represented by T. L. Mount, H. S. C. Folk, H. W. Beedle, R. I. Baird, F. P. Dereby, R. O. Miles, W. H. Payne, E. H. Watkins.

Fairbanks, Morse & Company, Chicago, Ill.—Space No. 70-A.—Motors and motor parts arranged to show construction and quality of a.c. and d.c. motors. Represented by P. H. Gilleland, F. M. Condit, H. E. Vogel, H. L. Hilleary, E. C. Golladay, C. H. Wilson, D. K. Lee, F. J. Lee, B. S. Spaulding, G. Howard, W. L. Nies, G. W. Lewis, C. T. Fugitt, C. B. O'Neil.

Frank Adam Electric Company, St. Louis, Mo.—Space No. 16.—Panelboards for the distribution of lighting circuits; flood lighting equipment manufactured by the Major Equipment Company who are representatives of the Frank Adam Electric Company. Represented by P. J. Rabon, B. F. Fuller.

General Electric Company, Schenectady, N. Y.—Spaces No. 36, 59 and 60.—Floodlights; motors; control; arc welding; industrial heating devices; soldering irons; Quartz tubes. Represented by R. F. Goggin, W. J. Hedley, B. S. Pero, F. P. Jones, F. I. Kittredge, J. J. Liles, Lynn Covey, R. L. Hughes, R. H. Parker, C. Dorticos, W. G. Ferguson, W. N. B. Brady, C. T. McLoughlin, John Roberts, C. C. Bailey.

Gould Car Lighting Corp., New York, N. Y.—Spaces No. 6 and 7.—Car lighting generators; regulators; turbo generator for locomotive headlights; light-weight car lighting batteries with glass wool separators; Plante car lighting batteries. Represented by C. R. Naylor, G. R. Berger, R. T. Knapp, P. H. Simpson, W. F. Bouche, E. J. Blake, M. R. Shedd.

Graybar Electric Company, Chicago, Ill.—Space No. 46.—Sheraduct conduit; Square D safety switches; Habirshaw wires and cables; Crouse-Hinds condulets, fittings and floodlights; Tirex cables; Graybar No. 99 lighting units; Graybar sunbeam Mazda lamps; National carbon batteries; Hubbard pole line hardware; Benjamin shop lighting fixtures; Speedway drills. Represented by G. H. Porter, E. J. O'Donnell, T. J. Rider, R. C. Kinney, Wm. Weiss, J. E. Barron, H. C. Gump, J. J.

O'Connor, H. C. Olmstead, E. M. Nelson, J. H. Gleason, A. G. Nabors.

Harvey-Hubbel, Inc., Bridgeport, Conn.—Space No. 23.—Switches; plugs; receptacles; lamp guards; reflectors; socket material. Represented by J. K. Utz, J. F. Ware, R. L. Renaud, E. P. Napier, A. W. Schwind, E. P. Doherty, L. G. Mockenhaupt.

Hazard Mfg. Co., Wilkes Barre, Pa.—Space No. 76½-A.—Railroad signal wires and cables, including spiral weave aerial cables and steel tape armored underground cables; train control wires and cables; locomotive headlight wire; submarine cables. Represented by T. A. Keefe, J. E. Ham, D. J. Morgan.

Henrite Products Company, Jersey City, N. J.—Space No. 80½-A.—

C. H. Hollup Corp., Chicago, Ill.—Space No. 44.—Processed bare and flux coated electrodes for electric welding; welding rods for oxy-acetylene welding; helmets; hand shields; welding lenses; holders; welding and cutting torches; regulators; sand blast equipment. Represented by H. R. Pennington, K. R. Hare.

Howell Electric Motors Company, Howell, Mich.—Space No. 64-A.—Red Band motors, featuring roller bearings. Represented by C. F. Norton, O. A. Reed, J. M. Johnson, D. S. Wilkus.

Industrial Controller Company, Milwaukee, Wis.—Spaces No. 29 and 30.—Manually operated a.c. compensator; a.c. motor circuit switch; a.c. automatic compensator; three types of a.c. automatic starters, across the line; a.c. automatic reversing starter; a.c. automatic starter, primary resistor type; three types of d.c. automatic starters; float switch. Represented by John McC. Price, R. F. Harrison, Earle J. Rooker, Ned Weller.

The Kerite Insulated Wire & Cable Company, Inc., New York, N. Y.—Space No. 5.—Insulated wires and cables. Represented by W. H. Fenley, E. L. Adams, C. A. Reeb, C. E. Hieber, C. M. Deardorff, E. M. Branchfield, M. D. Cook, J. A. Hamilton.

Loeffelholz Company, Milwaukee, Wis.—Space No. 45.—Gibb's train lighting receptacles, plugs and accessories; upper and lower berth lamps; car lighting fixtures and car lighting electrical appliances. Represented by L. R. Taylor, P. A. Bernhardt, G. B. Miller.

E. A. Lundy Company, Pittsburgh, Pa.—Spaces No. 71-A, 72-A, 73-A.—Line materials; reinforced switch clips; ampere-hour meters; Haworth Wej-Rite clamps; Kuhlman transformers; Balkite rectifiers. Represented by E. A. Lundy, C. G. McCaulley, Preston Paris, F. H. Schaeffer, J. S. Miller.

The Martindale Electric Company, Cleveland, Ohio.—Space No. 69-A.—Motor maintenance equipment; Universal ammeters; voltmeters; armature and field testers; commutator cement; commutator grinding tools; commutator slot insulating varnish; commutator slotting files; commutator slotting machines; commutator slotting saws; commutator stones; electrical etchers; megohm insulation meters; portable blowers; soldering transformer sets. Represented by E. H. Martindale, C. E. Lacey, Louis D. Moore.

Mercury Mfg. Co., Chicago, Ill.—Space No. 57—Type L worm drive electric tractors; type H internal gear drive electric tractors; industrial trailer equipment; automatic trailer coupler. Represented by J. R. Bensely, H. B. Clapp, L. R. Millar, W. D. Schlundt, A. D. Shanks, C. W. Henkle, L. J. Kline.

Mutual Electric & Machine Company, Detroit, Mich.—Space No. 1.—Bull Dog safety switches; lighting panels. Represented by E. A. Printz, J. E. Schwarz, F. M. McAdams.

National Lamp Works, Nela Park, Cleveland, Ohio.—Spaces No. 34 and 35.—Incandescent lamps. Represented by H. H. Helmbright, W. M. Langstaff.

National Train Control Company, Chicago, Ill.—Spaces No. 34 and 35.—Working demonstration of National automatic train control with permissive feature. Represented by E. C. Wilson, J. C. Anderson, E. W. Stone, C. E. Sampson.

The Okonite Company, Passaic, N. J.—Spaces No. 42 and 43.—Okonite rubber covered and varnished cambric insulated wires and cables for all services and voltages; Okocords for portable lights and train control service; friction and rubber tapes; Okonite-Callender paper insulated, supertension and impregnated paper cables; splicing materials; joint boxes, etc. Represented by J. D. Underhill, A. L. McNeill, R. N. Baker, F. J. White, E. H. McNeill, J. J. O'Brien, L. R. Mann.

Otis B. Duncan, Chicago, Ill.—Space No. 34½.—Battery charging motor generator sets; switchboards; commutator stones; commutator slotters; turning tool; commutator cement. Represented by Otis B. Duncan, L. C. Howard, H. P. F. Dering, George Jacobson.

The Pyle-National Company, Chicago, Ill.—Spaces No. 39, 40, 41, 54, 55 and 56.—Turbo generators; headlight cases; marker lamps; classification lamps; cab light fixtures; headlight switches; locomotive wiring fittings; shop wiring fittings; safety-first switches; train connectors; safety portable hand lamps, etc. Represented by J. W. Johnson, Wm. Miller, J. A. Amos, J. J. Kennedy, Crawford McGinnis, T. P. McGinnis, G. E. Hass, P. S. Westcott, E. H. Hagensick, G. V. Wright, W. A. Ross, W. M. Graves, Jr.

Railway Electrical Engineer, New York, N. Y.—Space No. 83-A.—Books and magazines. Represented by F. J. Fischer, R. F. Duysters, H. A. Morrison, R. S. Kenrick, C. J. Corse, A. G. Oehler.

Railway Purchases & Stores, Chicago, Ill.—Space No. 62-A.—Represented by H. B. Kirkland, J. P. Murphy, Jr., K. F. Sheeran, Edward Wray.

Railway Utility Company, Chicago, Ill.—Space No. 17.—Electric heaters; electric heat regulators; passenger car ventilators. Represented by E. J. Magerstadt, Wm. J. Pine, R. R. Holden, Wm. G. Hartwig, Albert Hirsch.

Roller-Smith Company, New York, N. Y.—Space No. 2.—Alternating and direct current switchboard instruments in various sizes and styles; direct current portable ammeters, voltmeters and volt-ammeters in small and large styles; alternating current portable ammeters, voltmeters, volt-ammeters, wattmeters, power factor meters and frequency meters; portable volt-ammeters and ohmmeters for signal system and automatic train control testing; Miscellaneous devices such as galvanometers, transformers, radio instruments, shunts, multipliers; circuit breakers in different types, capacities and combinations; new apparatus to be announced. Represented by G. L. Crosby, M. Frankel, M. B. Mathley.

The Safety Car Heating & Lighting Company, New Haven, Conn.—Spaces No. 47 and 48.—Electric car lighting fixtures; fans; Putnam type CLEG storage batteries; car lighting equipment including generators, generator regulators and lamp regulators for all type cars.

Represented by J. H. Henry, H. K. Williams, C. W. T. Stuart, A. V. Livingston, J. H. Rodger, C. A. Pinyard, G. D. Ladd, A. R. Hamilton, G. H. Scott, S. I. Hopkins, C. A. Chasey.

Simplex Wire & Cable Company, Boston, Mass.—Space No. 18.—Wires and cables.—Represented by L. S. Jones, W. F. Hruby, A. Hagen, C. J. Zeigler.

SKF Industries, Inc., New York, N. Y.—Space No. 75-A.—Ball bearing equipped truck showing the anti-friction qualities of ball and roller bearings. Represented by W. L. Batt, H. E. Brunner, R. H. DeMott, W. F. Temple, F. E. Ericson, C. L. Drake, R. C. Byler

Square D Company, Detroit, Mich—Space No. 68-A.—Industrial safety switches; convertible power panels; new 32-volt tester developed for the railroad field and designed for making tests on the turbo generator of steam locomotives. Represented by Russell Murphy, C. W. Bates, A. A. Schueler, R. J. Parisian.

Strom Ball Bearing Mfg. Co., Chicago, Ill.—Space No. 31.—Strom single-row and double-row radial, angular contact, thrust bearings; ball bearings for electric headlight generators and car lighting generators. Represented by G. A. Strom, H. N. Parsons, C. T. Olson, H. R. Higgins, Miss Cora C. Smith.

Sunbeam Electric Mfg. Co., Evansville, Ind.—Spaces No. 49 and 50.—Headlight turbo-generators; train control turbo-generators; glass reflector headlights; metal reflector headlights; headlight accessories. Represented by M. C. Peterson, C. E. Kinnaw, C. W. Marshall, W. T. Manogue, J. Henry Schroeder.

The Trumbull Electric Mfg. Co., Plainville, Conn.—Space No. 8.—

United States Graphite Company, Saginaw, Mich.—Space No. 77½-A.—Motor and generator brushes; carbon products; Mexican Graphite products. Represented by W. R. Pflasterer, N. B. McRee.

U. S. Light & Heat Corp., Niagara Falls, N. Y.—Space No. 58.—Car lighting battery; car lighting battery parts; special bus battery; USL electric arc welder; samples of electric welding. Represented by E. Bauer, W. L. Bliss, J. L. Fosnight, R. J. Stanton, A. W. Donop, E. K. Gordon, J. F. Romadka.

United States Rubber Company, New York, N. Y.—Space No. 11.—

Weber Brothers Metal Works, Chicago, Ill.—Space No. 24.—Improved Rochlitz automatic water still in various types. Represented by G. A. Stephen, W. H. Weber, W. M. Lalor.

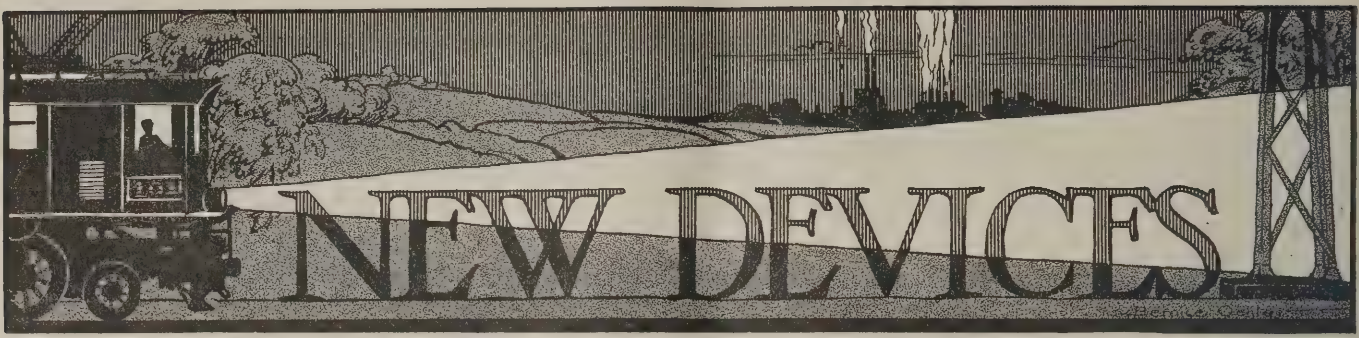
Westburg Engineering Company, Chicago, Ill.—Western selling agents for Weston Electric Instrument Corp., Newark, N. J.—Space No. 74-A.—Portable electrical indicating instruments for general railroad testing; tachometers including instruments suitable for locomotive speed indicators and railway private car speed indicators. Represented by P. A. Westburg, Leon C. Herrmann, Alvin Thielke, Kline Gray, J. F. Inman.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Spaces No. 81-A, and 82-A.—Flood lighting units with chromium plated reflectors; insulators; starters; insulating material; instruments; safety switches; lighting, etc. Represented by officials, sales representatives and engineers from headquarters and district offices.

Willard Storage Battery Company, Cleveland, Ohio.—Space No. 85-A.—Plante train lighting batteries; paste plate light weight train lighting batteries; paste plate house lighting and signal type time clock glass jar batteries; bus batteries. Represented by Louis Sears, C. T. Klug, C. E. Murray, M. J. Brennan.

Daniel Woodhead Company, Chicago, Ill.—Space No. 9.—Diehl fans (railway type); Candee rubber tape; Ackerman friction tape; Wheeler reflectors; Adapti fittings; Protex lamp guards. Represented by Daniel Woodhead, E. J. Biederman, R. B. McFeeley, H. H. Kerr, Jr.

A Section of the Electrified Staten Island Lines of the Baltimore & Ohio Near South Beach, S. I., Showing Two-Car Train, Outdoor Portion of Automatic Substation and the Double Transmission Line



Polarized Wiring Devices

The line of porcelain socket bodies and bases manufactured by the Arrow Electric Company of Hartford, Conn., has recently been completed. The new additions to the line consist of two and three wire polarized devices of 20 amperes capacity. A group of those designed for three wire use is shown in the photograph and consists of a composition cap, KA; a cord grip cap, KH; a flush receptacle No. 8140; a surface concealed base, No. 8145; a cord connector body, No. 8142, and an armored cord connector body, No. 8144.

A Group of 20-Ampere, 3-Wire, Polarized Device

The cord holes in the plug caps and the connector bodies are 3/8 in. while the armored cord grip cap KH and the conductor No. 8144 take wire from 7/16 to 3/8 in.

A similar line has been developed known as schedule P for 20 ampere, two wire, polarized circuits.

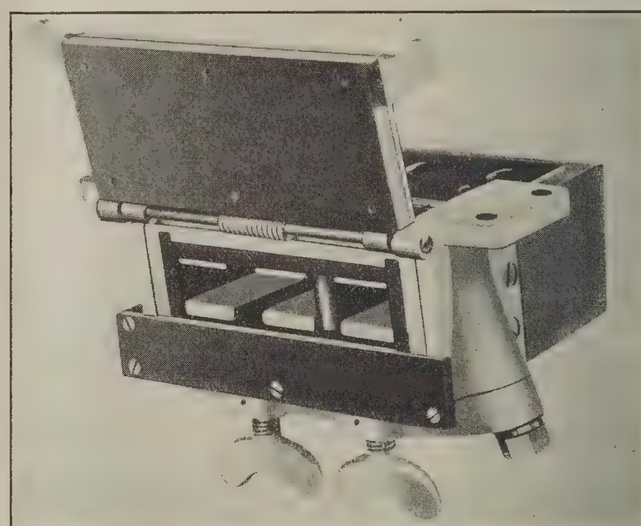
New Train Line Receptacle

A new form of Gibbs train connector receptacles constructed of a one-piece aluminum casting and insulated with Celeron Bakelite insulation is being marketed by the Loeffelholz Company of Milwaukee.

There are two models of this connector known as No. 2500, Fig. U and No. 3500, Fig. W, respectively. The former is for two-wire connector cables and the latter for three-wire cables.

All brass fitted conducting members are made of cast bronze and of phosphor bronze. The brass spring members are both riveted and soldered. Receptacle No. 2500 is intended for use on axle lighting units while No. 3500 is designed for use on head end units with single pole switch in circuit. This latter receptacle has no loop.

Both receptacles are weather proof and are equipped with improved detachable yoke or bracket made of cast phosphor bronze with nickel plated white rustproof finish.



One of the No. 3,500 Receptacles

Rheostat With Fine Adjustment

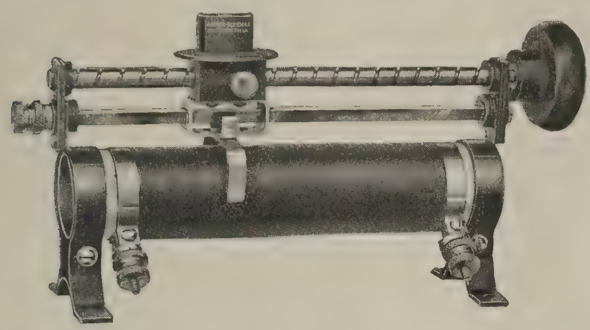
A new and improved design of a screw driven, sliding contact, tube rheostat has recently been developed by James G. Biddle of Philadelphia. The new rheostat is intended for use in meter departments and electrical workshops where fine adjustments of resistance are required.

The position of the slider is controlled by means of a coarsely threaded screw bar having a pitch of two threads per inch and operated by means of a knob attached to one end.

A rectangular driver block to which the slider box is attached slides on the screw bar and carries a knurled head projecting from the side. By means of this head a pin engaging with the screw may be disengaged and the slider moved freely by hand, independently of the screw driving mechanism. The screw rod and engaging pin and knurled head are entirely insulated from the live parts of the resistance. If desired, a crank may be used

at the end of the screw road instead of the knob, or a gear may be attached for rapid operation. The rheostat may be mounted in any position, holes in the feet being provided for the purpose.

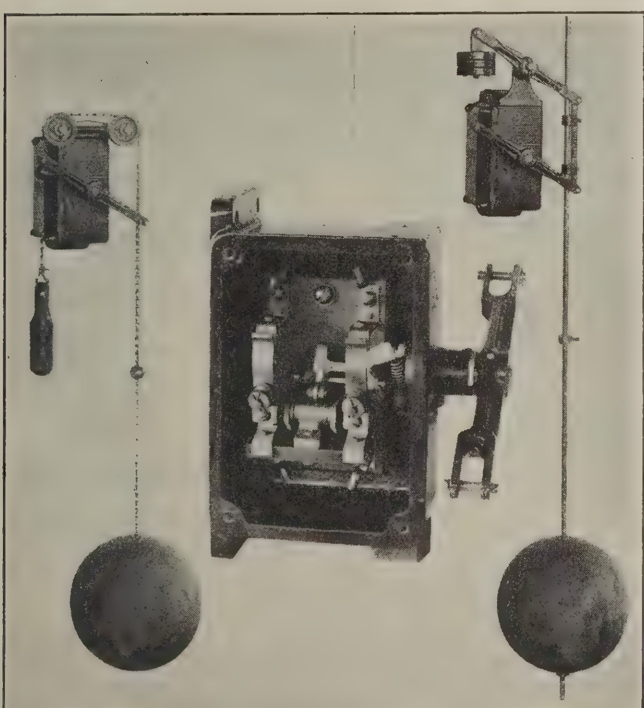
This line of rheostats is available in three sizes—8 in., 16 in., and 20 in. and the range of the current capacity varies from 0.1 amp. to 25 amp. while the range of resistance varies from 3,000 ohms to 0.34 ohms.



A Rheostat for Use in Meter Departments and Electrical Work Shops

Float Switch of Rugged Design

To meet the demand for a float switch of rugged construction for use at water tank pumping stations, the Industrial Controller Company of Milwaukee, Wis., has developed the devices shown in the photograph. The switching is primarily for use in the pilot circuit of an automatic resistance starter or automatic compensator. The mechanism is double pole and is also quick make and break. The break distance and size of contacts are sufficient to carry about 15 amperes. The enclosed case is cast iron and is waterproof and the contacts and contact pressure are sufficient to prevent trouble from corrosion.

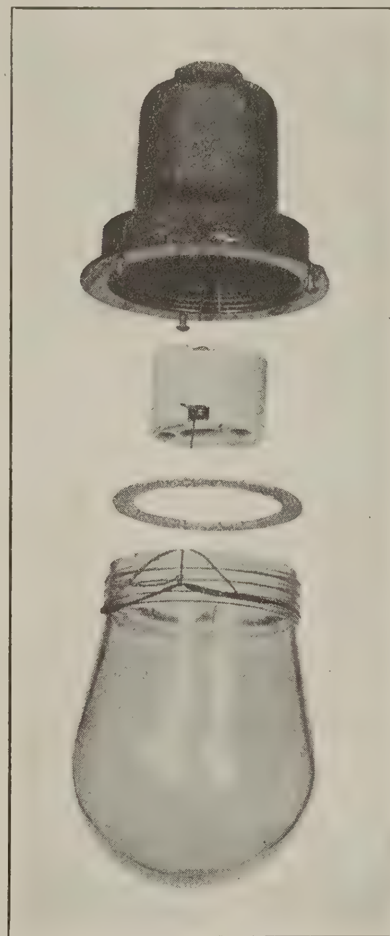


Float Switch Mechanism Showing Two Methods of Attaching Float Ball

As may be seen from the photographs, the float ball can be attached either by a rigid rod or by a chain as desired.

Improved Vapor-Proof Units

A line of improved vapor-proof lighting units has been designed by the Westinghouse Electric & Manufacturing Company. Each unit is composed of a minimum number of parts consisting of a globe, holder, socket and gasket. The holder or hood is made of cast iron and houses a front-connected socket and reflector. These sockets are so designed as to retain all the important features of Westinghouse reflector sockets.



The Unit Has a Cast Hood, Gasketed Globe and Front-Connected Socket

One of the features of this new line is that the vapor-proof globes are threaded to fit the cast iron hoods and seat on a special gasket which is unaffected by moisture and prevents the dust, smoke or vapor from reaching the lamp bulb. The hood is threaded for ½-inch conduit.

This type of unit has been used advantageously in oil refineries, dry cleaning establishments, dye houses, laundries, chemical works, powder mills and textile factories and is suitable for service in oil houses, pits, tunnels, basements and other places where vapors are present.

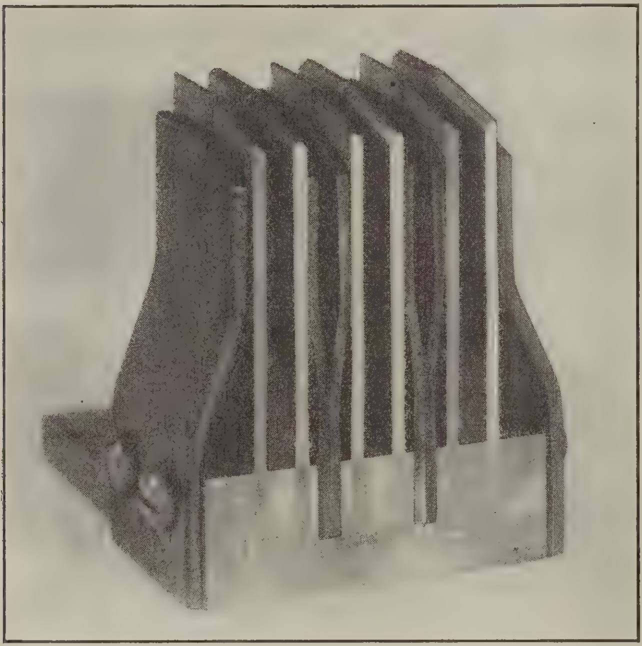
Reinforced Contacts for Multiple Blade Switches

A demand for a better type of contact between blades and jaws in multiple blade switches has resulted in the development of a stronger type of jaw by the Reinforced Switch & Manufacturing Company of Pittsburgh, Pa.

The idea involved is similar to the other lines of fuse clips and switch jaws which the company has been marketing for some time. Although the photograph shows the construction of the reinforced multiple switch jaw, some of the details are not visible in the

picture. The steel reinforcing is mounted between the several sets of jaws in such a manner that pressure is applied to the sides of the jaws causing them to press firmly against the sides of the switch blade when the switch is closed, thus insuring uniform contact between jaws and blades.

Both the switch jaw and the steel reinforcing springs are set in grooves cut in the block and are held firmly in place by two ¼ in. pins which extend through the block. The ends of the holes through which the pins



Switch Jaw Block Showing Manner of Applying Reinforcing Springs

are driven are tapped and threaded for 14-32 screws. Between the surface where the steel springs would normally press upon the jaws is inserted fibre insulation so that the steel does not act as a conductor when the switch is closed. Pieces of Bakelite are used in the lower part of the outer switch jaws and act as a stop against which the switch blades rest.

Chargers and Control Panels

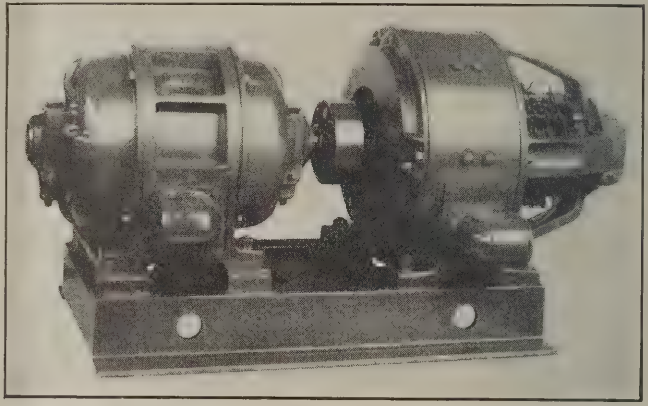
As a result of modifications of design, the General Electric Company is now marketing a complete new line of battery charging equipments in uniform frame sizes. These equipments consist of motor generators and unit control sections. They are applicable to the multiple charging of batteries used in electric industrial trucks, electric road trucks and storage battery locomotives.

The motor generators are designed to operate at speeds running from 1800 r.p.m., for the sizes up to 35 kilowatts, to 1200 r.p.m. on larger sizes. Stocks will be carried of outfits for such special voltages as 32, 45 and 55, together with the standard 115-volt type.

The generators are flat compounded between no load and three-quarter load, and have slightly drooping characteristics beyond the three-quarter load point.

The unit control sections for these motor generators will be furnished either as part of the complete charging equipment or separately. An important feature of the design is compactness, making it possible to control a large number of circuits in a limited space.

The general line consists of two-circuit sections designed for manual control of the charging rate and the

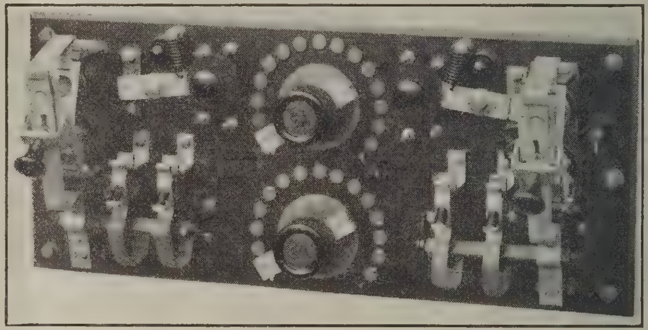


Motor Generator Set with a 25 Hp. 220-Volt, 60-Cycle Motor Driving a 16 Kw. 125-Volt Generator

terminating of the charge by means of a contact-making ampere-hour meter located on the truck.

By means of the indicating lamp the operator can tell when the battery is connected to the section. The current is controlled and adjusted by turning the dial switch handle.

Overcurrent protection is provided by the fuse, and



Charging Panel Used in Connection with Motor-Generator Set

protection against reversal is furnished by the undercurrent contactor.

An important feature of the construction is the ease with which a single section with its two resistors may be removed in a unit if necessary. This is accomplished by removing four cap crews at the corners of the panel and detaching the vertical bus bars from the back of the resistor supports. The entire section may then be easily slid out.

Megohm Insulation Meter

An instrument intended for making direct readings of insulation resistance between 200 ohms and 100,000,000 ohms is being marketed by the Martindale Electric Company of Cleveland, Ohio. The device is known as the Martindale megohm insulation meter. It consists of a box in which is housed a 500-volt d. c. generator that is operated by a crank. When the crank is turned at a speed of approximately 50 r.p.m. a clutch inside of the

case slips and the generator maintains a constant speed thereafter.

The three binding posts in the upper right hand corner constitute a switch for changing the scale reading. When the brass connector is connected to terminal "one" the readings are full scale and range from 3,000 ohms to

Meter for Reading High Resistances

100,000,000 ohms. When the connector is fastened to the terminal marked 1/10, the scale readings are divided by ten, making the range from 200 ohms to 10,000,000. The two large terminals at the left are the ones from which the leads are taken to the resistance to be measured.

The case is of wood and measures 6 in. by 7 in. by 8 in. The weight is 11 lb.

Locomotive Headlight Wire

The York Insulated Wire Works of the General Electric Company, 120 Broadway, N. Y., have developed a new locomotive headlight wire. The conductor is stranded, consisting of nineteen No. 27 soft drawn copper wires making it flexible and eliminating breakage caused by vibration in a wire of this class with a solid conductor.

The insulation consists of a solid wall .040 in. thick of pure long-fibre asbestos felted on the wire which is impregnated with a flame proof and moisture proof compound.

This compound makes the asbestos very tough and indestructible but causes no corrosion under any conditions. Over this asbestos insulation the wire has a coarse cotton braid applied very tightly so that it gives added protection to the conductor. This outer braid is impregnated with hot paraffine or a flame-proof varnish (optional) either adding to the waterproof qualities of the wire.

Improved Floodlighting Projector

The Pyle-National Company's Type No. 2375 Pyle-O-Lyte floodlight projector has been recently improved by the addition of a new terminal block placed in a housing which is a part of the cast aluminum alloy case of the projector.

The projector is completely wired from the lamp socket to the new terminal block with asbestos covered wire. The removable portion of the housing, as shown in the illustration, is provided with an Oliver strain relief bushing so that weatherproof wire can be brought up to the projector and held firmly by the strain relief bushing.

This new terminal block, with its housing and the

Type No. 2375 Pyle-O-Lite Projector as Equipped with Receptacle and Plug Connections

complete wiring inside the projector case, makes the installation of the projector very simple. Connections with the weatherproof wiring from the line to the projector are easily made by opening the housing and attaching the line wires to the standard terminals provided. A complete, flexible, permanent installation is easily made.

Vapor Proof Fitting

The Adapti Company of Cleveland, Ohio, has announced a refined type of vapor proof fitting for use in subways, tunnels, etc., which combines to a unique degree the advantages of both rigidity and flexibility. Adapti boxes are designed to meet future developments without the tearing down of fittings. In the vapor proof fitting they have maintained this desirable feature. This is accomplished by tapping four outlets and inserting plugs in three of the outlets. A rubber gasket under each plug assures a perfectly water tight joint. Either or all of these plugs can be removed when desired to make the required type or when changes or additions in the conduit system are to be made.

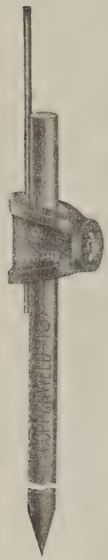
Vapor Proof Fitting

Interchangeability of globe sizes is an exclusive feature of the vapor proof fitting which makes it possible

to change from 60 watt to 100 watt light on the same base by simply substituting the desired globe and guard. In cases of breakage to either globe or guard the fitting remains dust and vapor proof. The fitting is approved by the underwriters' laboratories.

Grounding Wire Clamp

The grounding wire clamp shown in the illustration was designed by the Copperweld Steel Company of Rankin, Pa., for the purpose of permanently securing ground wires to Copperweld rods by mechanical means, eliminating the use of soldered connections, although solder may be used with the clamp if desired.



Grounding Wire Clamp

Great pressure may be exerted on the wire or strand by means of the cup-shaped screw or bolt without stretching or breaking the clamp. This pressure flattens the wire or strand, materially increasing the contact area. Two clamps may be used where additional contact is required or in multiple grounding, when connecting wires are of such a size that two will not fit the same clamp.

Clamps for ⅝ in. and larger, rods are built to accommodate strands as well as solid wires. When properly tightened, a pull of approximately one ton is necessary to cause wire or strand slippage.

When using the clamp, it is first attached loosely to the rod before driving. After the rod has been driven, the clamp is loosened and the ground wire slipped in position and the bolt previously mentioned is tightened up. When using stranded wire, the strands may be spread apart before inserting them in the clamp, thereby securing a maximum of contact surface when the clamp is finally drawn up into position.

Heavy Duty Electric Tractor

An interesting development in the tractor field is the type G heavy duty electric tractor for car switching and yard hauling. This large and powerful electric tractor is the product of the Mercury Manufacturing Company of Chicago. It has been designed to accommodate the following battery assemblies—30 cells, 33 plate Exide or equivalent lead—60 cells, A-12 Edison—120 cells, A-7 Edison in parallel with two sets of 60 cells each. The unit complete with battery will weigh approximately 11,000 lb. and will develop a draw bar pull in excess of 6,500 lb. The tractor has ample capacity to switch as many as three heavily laden freight cars and is commonly used for that purpose.

Due to the special three-wheel front assembly, this tractor can completely turn around in a circle 22 ft. in diameter and manoeuvre easily in most congested quarters, the overall length of the machine being 11 ft., 11 in.

The driving mechanism consists of a GE automotive type 1927 motor, 60 volts, 140 amperes, 1,350 r.p.m. This motor drives through a four-coil spring universal joint to a bevel pinion and gear having a gear reduction of four to one. The axle shaft running from the differential to the wheel pinion is full-floating and is made of alloy steel. The steel gears are composed of a pinion, three idlers and a ring gear giving a reduction of five to one. The motor gear reduction from motor to wheel is therefore, twenty to one.

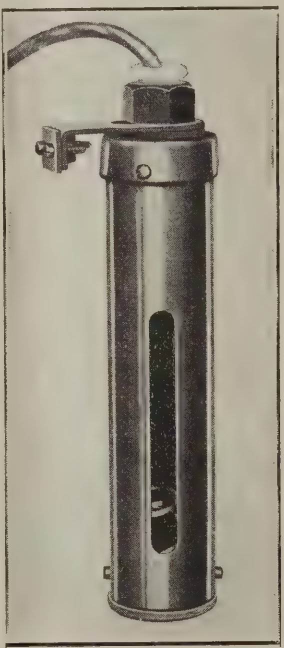
The speed of the tractor at no load is 12 miles per hour

A Tractor That Weighs 11,000 Lb. and Develops a Draw Bar Pull in Excess of 6500 Lb.

under which condition it takes a current of 110 amperes at 80 volts. When exerting a draw bar pull of 1,000 lb. a speed of 7½ miles per hour can be obtained with a current consumption of about 225 amperes. The cruising distance with a 10-ton load is approximately 50 miles.

Boiler Gauge Light

A boiler gauge light, consisting of a tubular reflector with a bayonet attachment to the socket flange, has been designed and is being manufactured by the Westinghouse Electric and Manufacturing Company. A compression spring serves to maintain the connection and to hold the lamp in place, so that neither the reflector nor the lamp can loosen under vibration.



Gauge Light That Resists Vibration

The design of the boiler gauge light permits mounting on the guard rail of any boiler water gauge or on the end of a ½-inch conduit used to carry wiring to the reflector. This mounting may be accomplished by the use of a screw driver. When it becomes necessary to change the lamp, no tools are needed to remove the reflector because one turn of the reflector disengages the bayonet attachment, and the lamp can then be screwed out of the standard socket.

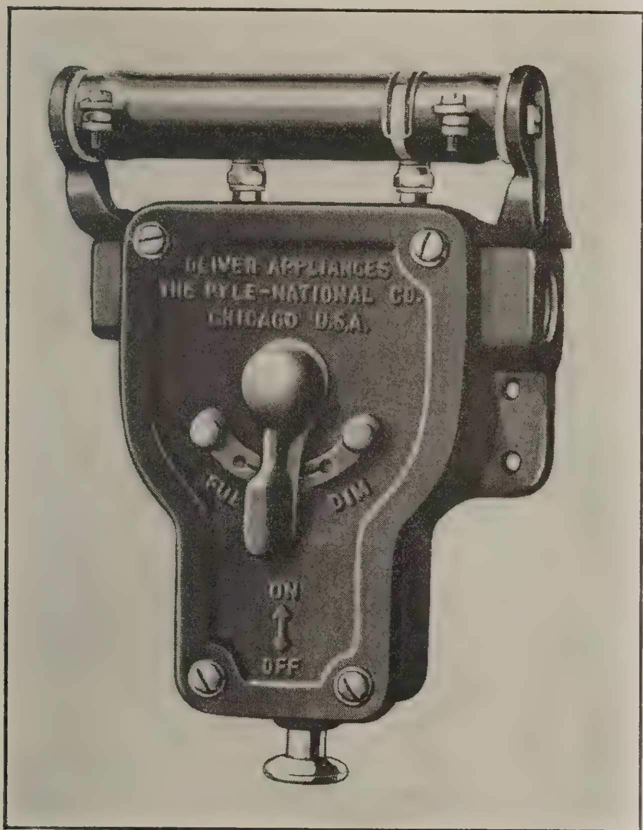
The reflector is made of heavy brass tubing with a slot in one side to throw the light on the water gauge only. The reflector is easily adjustable for any desirable mounting height and the mounting brackets are arranged to accommodate a wide range of positioning of the guard rods with relation to the gauge. A two-way conductor cord 48 in. long, and an attachment plug are

furnished regularly with the boiler gauge light. A standard tubular Mazda B lamp with T-10 bulb should be used.

New Headlight Switch

Type HSACR-22 headlight switch is a recent addition to the Oliver Electric Appliance line of locomotive wiring appliances. It comprises in one unit an "on," "off," and "dim" switch for one headlight, a resistance coil for dimming, mounted on top of the case, and a push and pull switch for controlling engineer's lamp, etc.

The housing of the new headlight switch is weather-



Type H S A C R-22 Headlight Switch

proof and dust-proof and has tapped conduit entrances as a part of the case.

Large contacts and a positive, smooth action make the switch easy to operate, and insure dependability.

The auxiliary switch for cab lamps on other control is the new Oliver push and pull type, with its definite action and indicating position.

Dustite Maxolite Reflector

The new Dustite Maxolite is listed for the first time in the No. 77 Maxolite catalog just published by the Central States General Electric Supply Company of Chicago. The holding hood is made of cast aluminum, threaded at the top for attaching to ¾ in. conduit, and fitted with a heavy porcelain socket.

There is a thread at the bottom to engage a cast iron threaded collar rolled into a heavy porcelain enamelled steel reflector.

The bottom opening is closed by a convex pyrex glass cover, offering exceptional heat resisting qualities.

The glass is sealed into the reflector with asbestos gaskets and held in place by aluminum ring and six screws.

The joint between the holder and the reflector is also

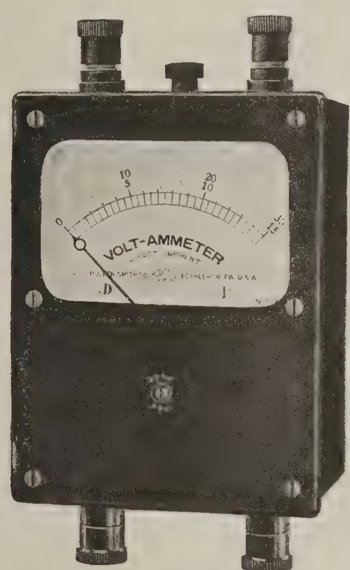
A New Reflector with Dust Tight Cover

sealed by an asbestos gasket making the reflector practically air tight.

This construction makes the unit especially desirable for such locations as roundhouses, train sheds, freight houses and other locations where cleaning is a real problem. This unit can be very easily and quickly restored to its initial efficiency by wiping off the under side of the glass cover.

Pocket Meters

To meet a demand for smaller pocket sized instruments the Roller-Smith Company of New York has developed a new line of voltmeters, ammeters and watt meters,



The Volt-Ammeter of the H. T. A. Line

known as the HTA type. The instruments are suitable for general testing of motor and generator circuits, light and power circuits, etc. Both a.c. and d.c. voltmeters are included in the line, each reading up to 300 volts.

The mechanism of the voltmeters and ammeters is of the electro-magnetic type while the watt meters operate on the electro-dynomometer principle with efficient air damping. All instruments are individually calibrated and are correct within 1½ per cent of full scale value. The illustration shows a volt-ammeter of this line which differs in appearance from the others by the fact that it has binding posts both top and bottom while the voltmeters and ammeters have binding posts only at the top.

Bernice Oehler

GENERAL NEWS

The Pennsylvania has placed orders for the electrical equipment for 128 multiple unit cars and the electrical equipment for eight new electric locomotives.

The American Brown Boveri Electric Corporation, Camden, N. J., announces that it has opened four district offices at the following points: 165 Broadway, New York, N. Y.; 230 South Clark Street, Chicago; 842 Summer Street, Boston, and 922 Witherspoon Building, Philadelphia.

The Louisiana Sunshine Special of the Missouri Pacific, northbound train No. 102, was derailed by malicious tampering with the track near McGehee, Ark., shortly after midnight of Monday, September 13, the locomotive being overturned and the engineman killed. The fireman and 19 passengers were injured. Unknown parties had removed angle bars and spikes from track.

Announcement is made by the New York executive offices of the Graybar Electric Company of change in management of their Providence and Grand Rapids distributing branches, effective September 1. A. Schwenck, sales manager at Grand Rapids, will assume the managership of the Providence branch, while Frank Caestecker of the Chicago branch will assume the managership duties at Grand Rapids.

The Atlantic Coast Line has ordered from the General Railway Signal Company, 70 complete locomotive equipments and 370 inductors for automatic train control. This system, the intermittent inductive auto manual type, is to be installed from South Rocky Mount, N. C., southward 172 miles, double track, to Florence, S. C., in compliance with the second order of the Interstate Commerce Commission.

The Interstate Commerce Commission has modified its train control order as to the Atchison, Topeka & Santa Fe to permit an installation between Chillicothe and Pequot, Ill., instead of between Chillicothe and Chicago, subject to the condition that both the track of the Santa Fe and that of the Chicago & Alton between Pequot and Joliet be promptly equipped with automatic signals.

The Kuhlman Electric Company, Bay City, Michigan, manufacturers of power, distribution and street lighting transformers, announces the opening of a direct factory branch office in Atlanta, Ga. The office is located at 411 Glenn building and is in charge of Ernest K. Higginbottom. During the past two years, Mr. Higginbottom has represented the company throughout the Southeast. Previous to that time his headquarters were at the main office and factory.

The Chicago, Milwaukee & St. Paul has ordered from the Union Switch & Signal Company material for automatic train control, the Union 2-speed continuous inductive system, to be installed on its line, double track, between LaCrosse, Wis, and Portage, Wis., 105 miles. This section of road adjoins the section between Bridge Switch and Hastings, on which Union automatic train stops were installed last year. Equipment for 28 additional locomotives is included in the present order.

A Correction

On page 288 of the September issue of the *Railway Electrical Engineer* in the wiring diagram of the electric baking oven, there is an error which should be corrected. At the lower part of the sketch a two-pole, double throw switch is symbolically illustrated. As shown in the diagram the two upper terminals of this switch are permanently connected together, which is wrong. This connection should be omitted.

Westinghouse Reorganization

The general engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been re-organized. This necessitated the re-allocation of several engineers, four being promoted to managers of engineering. These are: F. C. Hanker, manager of central station engineering; S. B. Cooper, manager of railway engineering; G. E. Stoltz, manager of industrial engineering, and W. E. Thau, manager of marine engineering. S. A. Staege, formerly section engineer in charge of the paper mill section, has been appointed industrial engineer, giving particular attention to the paper mill industry. Other departments appointments are: Central station engineering. C. A. Powel, engineer, generating station engineering; R. D. Evans, engineer, transmission engineering, and

C. A. Butcher, engineer, substation engineering. Railway engineering: H. K. Smith, engineer, heavy traction engineering; G. M. Woods, engineer, light traction engineering, and A. H. Candee, engineer, gas-electric traction engineering. Industrial engineering; E. M. Bouton, engineer, elevator engineering; C. W. Drake, engineer, general industrial engineering; C. T. Guildford, engineer, textile engineering; C. H. Matthews, engineer, mining engineering; O. Needham, engineer, steel mill engineering; J. W. Speer, engineer, material handling engineering; W. W. Spratt, engineer, paper mill engineering, and E. B. Dawson, engineer, electro-chemical and electro-metallurgical engineering. N. W. Storer was appointed consulting railway engineer in charge of the group handling of Diesel-electric locomotives and rail cars.

Japan to Have a Subway

The first transportation subway in a city of the distant East is under construction in Tokyo, where traffic congestion above ground between two important sections made it necessary to go underground to obtain added facilities.

The subway is being constructed in a manner similar to that used for downtown New York in that it is open cut and roofed over with steel, the tube being square and located a comparatively short distance below the surface of the street. The civil engineering work of this link, which will connect two very densely populated sections of Tokyo, has been about fifty per cent completed.

The first rolling stock will include ten steel cars, each of which at first will be provided with two motors of 120 horsepower rating. Two more motors will be added later to enable the cars to be trained up with one trailer per motor car. The motors are being furnished by the International General Electric Company, through Mitsui Bussan Kaisha.

The subway now under construction is one of ten sections projected for Tokyo, this section being constructed by the privately-owned Tokyo Underground Railway Company. The other nine sections may be constructed by the Tokyo municipality in the future.

World's Largest Turbine

A steam turbine generator unit rated at 208,000 kw. —about three times as large as any of the giants in service today—is being manufactured by the General Electric Company at Schenectady, N. Y., as the first unit for the world's newest and largest electric generating station, that of the State Line Generating Company on the Lake Michigan shore, on the Indiana side of the Indiana-Illinois state line.

The turbine-generator will be unique in many respects. Not only will it be the largest, but it will incorporate the largest 1,800 r.p.m. generator ever constructed, it will be the first to use live steam for reheating, and it will be the first turbine-generator to generate current at 18,000 volts. The boiler pressure used will be 600 lb.

The State Line Generating Company station, with a contemplated capacity of 1,000,000 kilowatts or about 1,335,000 horsepower, will be many times larger than any steam-operated electric plant now in existence. The plant itself marks a new era in power production, in that it will serve exclusively as a producer and wholesaler of electricity. It will produce electric energy for the interconnected power companies of the Chicago-Illinois-Indiana district.

Fall Meeting American Welding Society

Technical sessions, exhibitions and demonstrations will be held in connection with the annual fall meeting of the American Welding Society at the Broadway Auditorium, Buffalo, N. Y., November 16, 17, 18 and 19. A large variety of welded products will be a unique feature of the exposition of welding apparatus and supplies which will open on Tuesday afternoon, November 16. The technical sessions will begin Wednesday morning at 10 a. m. During these sessions the progress made by the welding research department of the American Welding Society (American Bureau of Welding) will be discussed. The program for the meeting is as follows:

WEDNESDAY, NOVEMBER 17

Morning

Welding of Locomotive Parts, by M. Gjersten, Master welder, Northern Pacific Company.

Organization of Welding on the Railroad, by F. H. Williams, assistant test engineer, Canadian National.

Afternoon

Comparative Tests on Arc and Riveted Structural Members, by A. M. Candy, general engineering department, Westinghouse Electric & Manufacturing Company.

Tests on Welded Roof Truss, by H. H. Moss, Linde Air Products Company.

THURSDAY, NOVEMBER 18

Morning

Welding Science in the Engineering Curriculum of Universities, by Prof. G. J. Hoffman, Purdue University; Prof. B. L. Lucas, Mississippi Agriculture and Mechanical College; Prof. S. T. Hart, Syracuse University; Professor de Zafra, New York University; Prof. R. D. Rickley, Ohio State University; Prof. F. V. Larkin, Lehigh University.

Afternoon

Welding Wire Specifications' Committee, C. A. McCune, chairman.

Meeting of the American Bureau of Welding.

Dinner dance.

FRIDAY, NOVEMBER 19

Morning

Short technical session on Welding in a Gaseous Atmosphere, including demonstrations, and exhibitions will be made by P. P. Alexander and R. A. Weinman of the General Electric Company.

Meeting of board of directors.

Afternoon

Inspection trip to Niagara Falls Power House.

Personals

Carl G. Schluederberg has been appointed general manager of the George Cutter Company, South Bend, Ind. The George Cutter Company is a subsidiary of the Westinghouse Electric Company in which street industrial and commercial lighting equipment and battery chargers are manufactured.

In his duties as general manager of the George Cutter Company, Mr. Schluederberg will be in charge of all the operations by and through that company, including sales, engineering and manufacturing. His appointment was made in anticipation of the departure of Mr. Warren Ripple, vice president and treasurer of the George Cutter Company, who, on account of ill health, has been impelled to tender his resignation, which has been accepted as effective September 30.

Mr. Schluederberg was born in Pittsburgh, Pa., and received his preparation for college in the Kiskiminetas

Springs Preparatory School. He was graduated from Cornell University in 1902 with degrees in mechanical and electrical engineering and, after a three-year interval, returned for postgraduate work in electro-chemistry. In 1908, he received his doctor of philosophy degree from Cornell University.


C. G. Schluederberg

Upon his graduation from college he entered the employ of the Westinghouse Electric Company as an electrical apprentice and a year later was assigned to the Pittsburgh district office, engaged in sales work. After receiving his graduate degree, Mr. Schleuderberg served as metallurgical engineer for the Carnegie Steel Company, Pittsburgh, and then accepted a position as electrical and mechanical engineer with the United Coal Company, in which he had charge of 10 electric plants of that company and which position he retained until 1910, when he again entered the employ of the Westinghouse Company, remaining with that company ever since.

George W. Daves, sales representative for the Fairmont Railway Motors, Inc., with headquarters in New York, resigned, effective August 18, to accept the position as railway representative for the Copperweld Steel Company with headquarters in Chicago. In 1898 Mr. Daves entered the employ of the Central Railroad of New Jersey as a messenger boy and in 1901 was promoted to rodman in the engineering corps. Soon after he was transferred to the signal department and in 1903 resigned his position to enter the service of the Union Switch & Signal Company. In 1905, Mr. Daves joined the signal department forces of the Long Island and in October of that year he resigned to take a position as signal inspector on the Chicago & Alton, with headquarters at Bloomington, Ill. On September 1, 1908, he was appointed signal engineer of that road, resigning on November 1, 1910, to become sales engineer for the Railroad Supply Company of Chicago. In March of 1912 he was appointed sales engineer of the Edison Storage Battery Company, remaining with that company until 1917, when he again returned to the Railroad Supply Company as sales engineer, with offices in New York. In September, 1917, Mr. Daves enlisted in the United States Army and was attached to the 413 Battalion, Railway Signal Corps, and served overseas as a master signal electrician. After 22 months of foreign service he returned to this country and was honorably discharged in August, 1919. In November of that year he entered the automotive division of the Prest-O-Lite Company, Inc., as sales representative on storage batteries and resigned to become affiliated with the Ray Battery Company in November, 1920. On April 1, 1923, he resigned his position as sales and service manager with that company and on June 1, 1923, joined the advertising forces of *Railway Signaling,* which position he held until his appointment as business manager of the publication in March, 1924. Mr. Daves later became affiliated with the Fairmont Railway Motors, Inc., as sales representative in New York, remaining until August 15, when he resigned to become a representative of "Copperweld" in the Chicago territory with the Steel Sales Corporation, located at 129 So. Jefferson St., Chicago, where Mr. Daves will make his new headquarters.


George W. Daves

Charles E. Sampson has been appointed service engineer for the National Safety Appliance Company, with headquarters at Chicago. His first signal experience was obtained on the Chicago & Alton, where he was engaged in construction and maintenance work from 1914 to 1918. In the latter year he enlisted in the U. S. Navy and was an electrician's mate (first class) when released from active service in September, 1919. He returned to the Chicago & Alton in October, 1919, and remained until 1921, when he accepted a position with the New York Central on signal construction work. Leaving the latter road in 1923, he entered the employ of the Illinois Central on signal construction work and six months later joined the service of the Pierce Electric Company, Chicago, on signal construction work in connection with the electrification of the Illinois Central's suburban service in the Chicago terminal, where he remained until his recent appointment.

R. J. Tiedeken has been appointed raw material salesman for the Bridgeport Brass Company in the Philadelphia territory. Mr. Tiedeken is familiar with the manufacture and sale of brass goods, having been engaged in the business since 1903, at first with the A. P. Swoyer Company, with whom he held various positions until 1921. Later he joined the U. T. Hungerford Company, also manufacturers of brass and copper products, representing them in Philadelphia for a short period. Subsequently, he was connected with the Carey-McFall Company, with which company he remained until joining the Bridgeport Brass Company. Mr. Tiedeken will make his headquarters at the Philadelphia office of the Bridgeport Brass Company in the Bankers Trust building.

F. L. Townsend, sales engineer of the Condit Manufacturing Corporation, at Boston, Mass., a subsidiary of the American Brown Boveri Electric Corporation, Camden, N. J., has been transferred to the New York office of the American Brown Boveri Electric Corporation and will conduct the sales of automatic voltage regulators, current limiting regulators and automatic synchronizers as well as other central station equipment.

Railway Electrical Engineer

Volume 17 NOVEMBER, 1926 No. 11

Make It Your Department

In the two preceding issues of the *Railway Electrical Engineer* announcements were made that first, second and third prizes will be awarded for descriptions of electrical kinks. The readers have responded well to this offer and the ideas which have been sent in will be published in subsequent issues in the Interchange department. Interchange, in this case is intended to convey the thought that through this department the electrical men can exchange ideas.

This issue has been delayed so that the proceedings of the Association of Railway Electrical Engineers can be included and because of this delay, the prize contest will close before all the subscribers have received their copies. The closing of the contest, however, has nothing to do with the regular procedure of the Interchange department. Contributions are always welcome and all those which are acceptable will be paid for at regular space rates.

The contest has simply served to show that there are many worth-while ideas in the field and that those who have worked out these kinks are able to tell what they are and how they work. A large number of kinks have been received and practically all of those sent in have been acceptable. As they are published, you will discover new ideas and you will also see some kinks which are similar to others you yourself may have worked out. Your kink is probably different and possibly better. Write and tell us about it so that we can pass it along to the other readers.

Seventeenth Annual Convention

The convention of the Association of Railway Electrical Engineers, which was held at the Hotel Sherman in Chicago from October 26 to 29 inclusive, brought together a larger group of railway electrical men than any previous meeting of the association. This statement will practically bear repetition each year, for as the various applications of electrical energy to steam railroad requirements increase in number, the attendance will continue to increase. The organization is continually growing, not only in membership, but in its importance with regard to the adoption of numerous standards for electrical equipment on the railroads. There are now 444 active members in the association and 164 associate members.

The association is doing excellent work along the lines which it has set out to follow. Within the past year manuals on lighting, electric welding and general practices have been compiled. One of the most notable achievements was its advocacy of electric welding. The electrical engineers were pioneers in this field and through their consistent and persistent efforts to incorporate electric welding in the field of railroad operation, they have rendered their employers invaluable assistance.

Today other problems are requiring their attention. Train control, self-propelled cars, and communication between locomotive and caboose on long freight trains are among the more important. All of these were discussed at length at the convention. Train control has been installed on many roads, but there are still numerous maintenance problems to be worked out and the same may be said of the self-propelled cars. The field of train communication, however, is new and while it apparently presents many obstacles it is quite within reason to expect a practical solution of the problem at no far distant date.

Training Electrical Maintainers

Headlight maintainers, car lighting maintainers and shop electricians have recently had a number of special problems presented to them that will probably make their work in the future much more interesting and attractive. In most cases where train control has been installed, it has become the duty of some of these men to maintain the apparatus on the locomotives. This means that they have many new things to learn and that the standard of headlight maintenance work must be raised to meet train control requirements. Gas-electric rail cars are being used in increasing numbers. These introduce other and different electrical apparatus to the maintainer, including that used for lighting these cars. Relatively little information on these new subjects is available. The *Railway Electrical Engineer* is constantly supplying information on these subjects, and this can effectively be augmented by questions and answers provided by supervisors and department heads.

An eastern railroad has recently prepared a long list of questions pertaining to headlight maintenance. Typical questions are in substance as follows: What causes proper voltage and poor regulation; how are governor adjustments made; why is a steam strainer used? Once a month each headlight maintainer is given

a list of ten of these questions to answer. His answers are checked by the supervisor and returned to him with correct answers in case his are wrong or incomplete. A similar list of questions has been prepared in connection with train lighting work and in each case the result so far as the railroad is concerned has been a noticeable improvement in the character of the work done.

As an aid to the men doing the work this sort of procedure is of much value. It stimulates interest and gives a good man an opportunity to show that he knows how to do his work. It also causes the men to discuss their problems among themselves. Every one should know how to make himself understood on paper and answering the questions is excellent practice. The success of the plan depends a great deal on the nature and wording of the questions. They should not be so difficult as to be irksome, and over a period of time new questions can be added to include work outside that which the men are doing from day to day. Results have already proven the value of this practice to the railroad in improved maintenance and if it is continued and enlarged, the men now in the shops and yards will be better able to cope with any of the new problems without the necessity of calling in specially trained men from the outside.

Radio on Trains

A few experiments have been made with radio as a means of communication between the locomotive and the caboose of long freight trains, but up to the present most of the work done has been confined to broadcast reception on passenger cars. This has been a logical development, since broadcast stations are distributed so as to be within reach of any train in the United States and Canada and radio receivers suitable for use on trains have been brought to a high state of perfection. So far as amusement reception on passenger trains is concerned it therefore remained with those men giving attention to the subject, to establish the best kind of car roof antenna and to select the receiving apparatus best suited to this kind of service. Excellent work covering this application has been done by the radio committee of the Association of Railway Electrical Engineers.

To adapt radio as a means of communication between the front and rear ends of freight trains involves much greater difficulties, as transmitting apparatus is relatively complicated and expensive and may require more electric power than can readily be provided. The value of such communication has already been established by stringing a wire along the tops of the cars on a long freight train. Many delays were avoided and the total time on the road was reduced sufficiently to warrant considerable expense for the apparatus used for communication.

Realizing the advantages of such communication, a number of railroad men have declared themselves willing to spend both time and money to develop telephonic communication between engine and caboose. Their spirit is worthy of commendation and they should be given every encouragement. It is also to be hoped that all efforts toward this end will not be confined to apparatus which will permit talking back and forth. Perfected apparatus to meet these requirements is not available and much tedious development work is necessary. It may be that too much enthusiasm will have a retarding effect. If all work is limited to the telephone and progress is slow, there may be objections raised to railroads doing unnecessary development work. If on the other hand, some of the experimenters will confine their efforts to the use of telegraphic or code equipment, progress is almost certain to be more rapid. It will be relatively a simple matter to equip a caboose with a sending outfit which will transmit signals in whistle code to the locomotive and to rely on the steam whistle to reply to these signals. This second means of communication is not as desirable as the first, but it is much easier of solution and if both means are tried, a setback is less probable and the possibilities of freight train communication will be realized in the shortest possible time.

Standardization of Reports

The committee which has in hand the preparation of material for the manual of the Association of Railway Electrical Engineer has stressed the point that a uniform and standard method of writing reports should be adopted. Although this may not seem of great importance to those presenting reports, it is nevertheless a large factor in the work of preparing such reports for the manual. The work would be greatly facilitated if some standard or standards could be adopted; it would make the task of editing the reports much easier and would result in the saving of time as well.

To the matter of uniform standards for report outlines may well be added the manner in which reports are actually written. Reports written with single line spacing are difficult to edit, as they allow little or no room for corrections or insertions of any kind. It is also well to stress the point of presenting a clear cut copy. A fourth or fifth carbon copy on thin paper is often so indistinct that it can be only read with much difficulty with the result that errors are almost sure to creep in when the report is set up in type. These are perhaps minor details but if the various committees would keep them in mind in the preparation of subsequent reports, it would greatly facilitate editing and at the same time reduce the liability of error to a minimum.

New Books

Safety Rules for the Operation of Electrical Equipment and Lines.—64 pages, 5 in. by 7¾ in. Paper covered. Published by the Bureau of Standards of the Department of Commerce, Washington, D. C. Price $ .15.

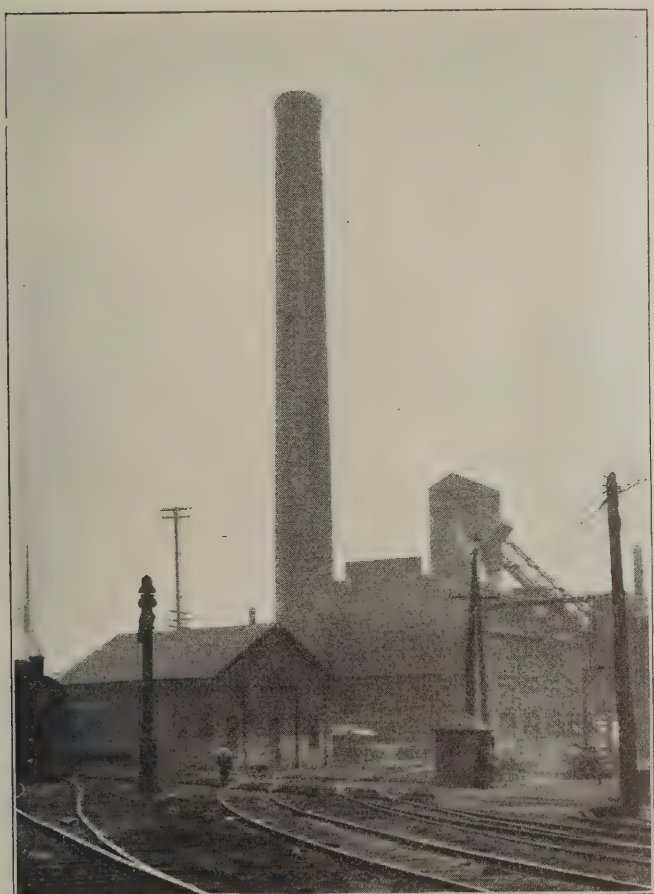
The pamphlet comprises part four of the fourth edition of the National Electric Safety Code. The volume deals with rules for the operation of electrical equipment of lines. The present edition of these rules has been carried out according to the procedure of the American Engineering Standards Committee and the revised rules have had the approval of the sectional committee, organized in conformity with those rules of procedure.

New Power Plant for Erie at Jersey City

Modern Buildings and Equipment Replace Old and Inefficient Units Distributed Throughout Terminal

ALTHOUGH the new power plant recently placed in service at the terminal of the Erie Railroad in Jersey City is designed primarily for the output of steam and compressed air, there are so many applications of electrical equipment woven into its construction that the plant is of interest to electrical men who may have similar operating conditions to contend with.

The new plant is centrally located as regards the buildings which it serves, a factor which makes for economy in the distribution of steam and compressed air.



Erie Power House at Jersey City

The main building is 98 ft. long and 61 ft. wide and a height of 37 ft. at the eaves with an extreme height at the ridge of 51 ft. The compressor room is adjacent to the boiler room and is 72 ft. long and 26 ft. wide being 26 ft. high to the eaves. The smoke stack is located on the north side of the main building. It is constructed of radical brick and is 200 ft. high having an inside diameter at the top of 12 ft. The boilers are connected to the stack with a flue 6 ft. by 8 ft.

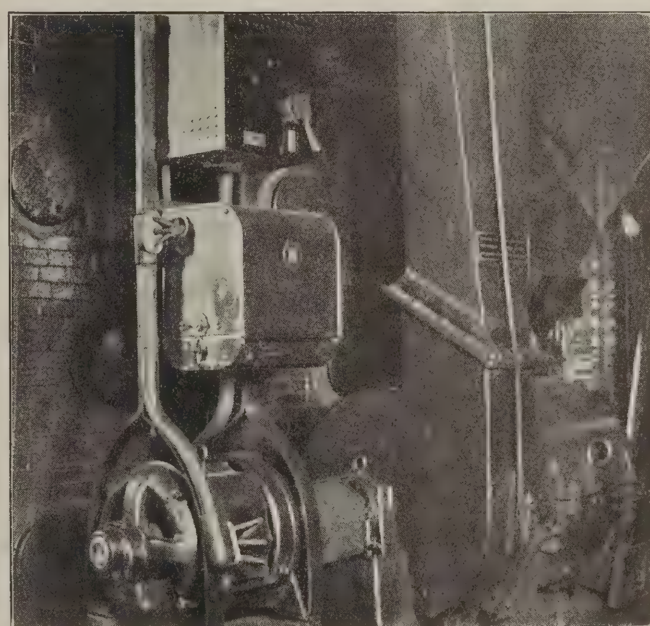
Boiler Capacity

Ten Foster Marine type boilers of 237.5 hp. each form the main source of power. Each of these is equipped with a superheater designed to add 100 deg. Fahrenheit of superheat to the steam. The boilers are set at 200 lb. steam pressure and they have a peak load rating of 250 per cent, although they are operated at present at 175 per cent with 200 lb. steam pressure.

The furnaces are of the Dutch oven type, equipped with Detrick flat suspended arch. Over the arch is applied a jacket plate and beneath this and between it and the arch, air is circulated and then admitted into the coal pulverizers with which each of the boilers is fed, at a temperature of 150 deg. Fahrenheit. This allows the coal to be handled when it is either wet or frozen.

Compressor Room

There are two large air compressors in the compressor room although either one of these is usually sufficient to meet the requirements. The steam driven compressor which is the one normally used has a capacity of 2200 cu. ft. per minute. The second of the two larger compressors is driven by 265 hp. synchronous motor. This latter compressor is held in reserve. Both of these large compressors were built by the Ingersol-Rand Company. In addition to the two large compressors there is a smaller steam driven Chicago Pneumatic Company's machine of 650 cu. ft. capacity.



Motor and Controller Driving Coal Pulverizer in Front of One of the Boilers

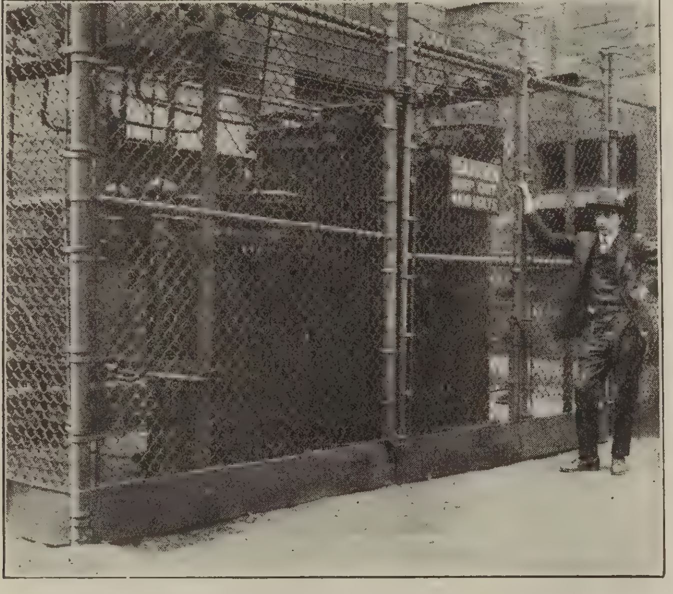
Electrical Energy Supply and Construction

With a few minor exceptions, no electrical power is developed at the new plant. Electrical energy is purchased from a commercial power company at 4200 volts, three phase, 60 cycle and is brought through underground 3 in. conduit from the street in lead covered cables to outdoor substation close to the main building. Here the voltage

is transformed by means of a Scott connected transformer to 2 phase, 2300 volts.

This same power supply had previously been furnished to a switchboard located in the machine shop in another part of the yard and considerable construction work was involved in running lines of underground conduit to meet the changed conditions. In putting in new lines from the power house to the round house and from the street to the power house, about 6000 ft. of 3 in. conduit had to be laid. The electrical work commenced in 1924 and the plant was placed in service about a year later. The mechanical details of the building extended over such a long period that a large gang of electricians was not necessary at any time and most of the wiring was done by four electricians.

The switchboard, which had been located in the machine shop connected to the round house, had to be moved to the new power house and put into position in a balcony in one corner of the compressor room, the distance between the old location of the board and the new one being



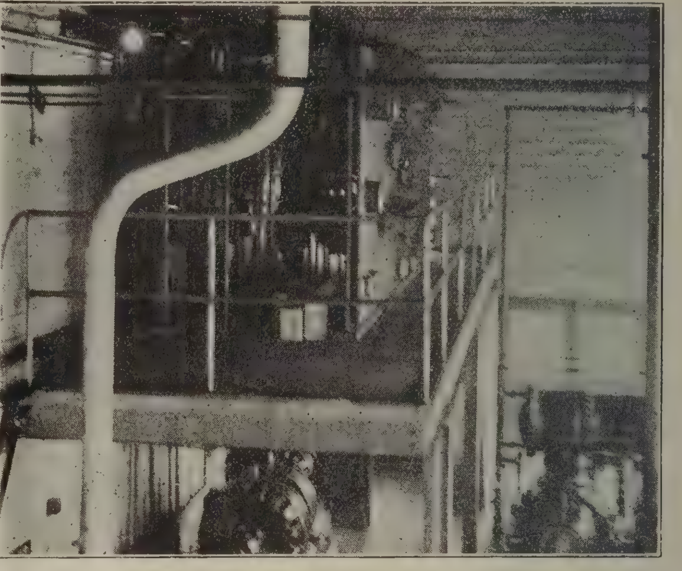
Transformer Station Where Purchased Power is Changed From Three to Two Phase

approximately 500 ft. Space was so restricted in the new position that it was necessary to set up the board in two parts, facing away from each other, with the wiring and connections between the front and rear boards. Moreover, this board was considerably increased in size from what it was when located in the machine shop.

The power panel for the distribution of power and lighting circuits in the roundhouse was installed at a point in the machine shop close to the place where the switchboard had formerly been located and all of this latter changing had to be done with the circuits alive. In fact the only shut down that was necessary in making the entire change from the machine shop to the power house, was when the commercial company changed the location of the auto transformers, at which time the plant was shut down for ten hours.

Switchboard Apparatus

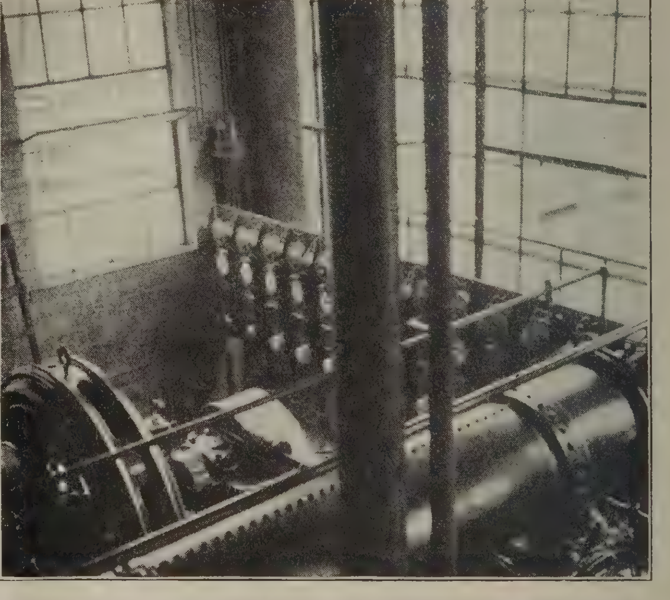
On the switchboard one of the panels carries metering equipment by means of which the current purchased from the commercial company is measured. This is followed by a main 2300-volt oil switch and next by an oil switch used in starting the 2300-volt synchronous motor on the air compressor. The fourth panel carries the main knife switch which controls the 220-volt service for both power and lighting, and this is followed by the distribution panel



The Switchboard is Located in a Balcony Above the Compressor Room

for the 220-volt current and one 110-volt lighting panel. A direct current control panel follows and finally a panel controlling the welding circuits. All of this apparatus is located on the front switchboard which faces the compressor room.

On the rear switchboard much more equipment is



View From Switchboard Balcony Showing Part of the Synchronous Motor Driven Compressor and Bank of Flow Meters

located. First there are two 2300-volt oil switches. One of these feeds the Jersey City terminal which includes the depot, ferry house and other buildings, and the second oil switch is a spare. A main switch which feeds a bank of six transformers in a vault below the floor of the compressor room follows. These transformers supply the 220-volt and 110-volt current to the power house, round

house and buildings in the vicinity. Next in order is a yard circuit oil switch. This is followed by a 220-volt power panel and this in turn by a final panel which takes care of the emergency lighting in the power house.

There are several panels to be installed which will carry watt hour meters for the purpose of recording the current used in the several shops and buildings in the terminal.

Other Equipment

Among the most interesting features of the plant is a coal handling equipment. The coal is supplied to the plant

Flow Meters Register the Consumption of Air and Steam by the Different Departments

by means of a R. H. Beaumont skip hoist from a spur track on the west side of the main building. The coal is dumped into a chute and is picked up by a bucket which has a capacity of 60 cu. ft. The bucket makes a complete cycle in two minutes, seven seconds, handling 40 tons of coal per hour. After being carried to the top of the hoist, the coal goes to the crusher which is operated by a 25 hp. induction motor. From the crusher it is dropped onto a belt and carried over a Cutler-Hammer magnetic separator which removes any tramp iron which may be carried in the coal. It then falls into a 500 ton bunker and from the bunker the coal is drawn by a larry, equipped with a weighing machine of two tons capacity, which travels on overhead rails in the center of the boiler room. This conveyor is operated by a 10 hp. induction motor. The fuel is distributed to ten pulverizers and is forced by air into the boiler furnaces where it ignites. Each pulverizer has a capacity of 2,000 lb. of coal per hour and the fuel is so finely divided that 80 per cent of it will pass through a 200 mesh screen. Of the ten pulverizers in use in the power house, four are electrically driven by a Westinghouse 40 hp. squirrel cage, direct connected motor equipped with U-re-lite circuit breakers. The other six are operated by Westinghouse steam turbines.

In the compressor room is placed one centrifugal boiler feed pump, driven by a 75 hp. 220-volt a.c. motor. A motor generator set used for battery charging and teleautograph system is also located in this room.

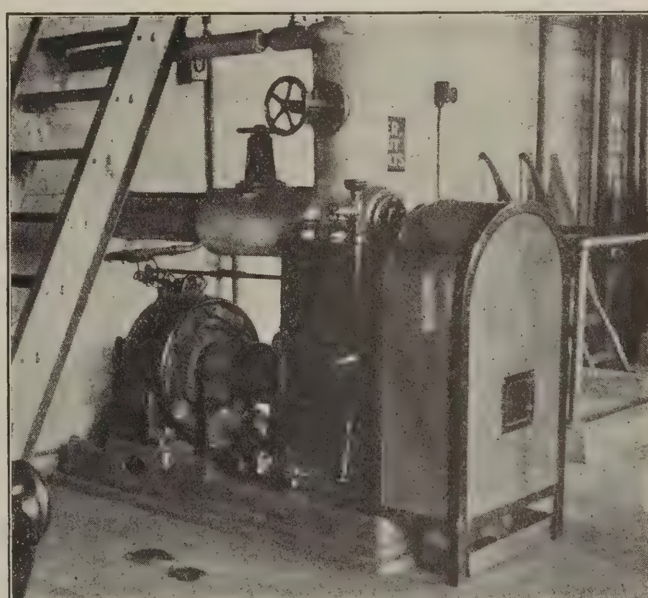
In making the changes in connection with the new work, improvements were also made in the welding facilities. A welding machine driven by a motor of 100 hp. capacity coupled to a generator with an output of 1,000 amp. feeds current over two 1,000,000 circular mill cables throughout the round house. It is of interest to note the generator of this machine was originally a compound direct current generator which had been used for charging batteries before being put into service as a welding machine.

The facilities for welding are such that all that is necessary is for the welding operator to plug into receptacles in almost any position in the round house and regulate the current he desires by means of a portable resistor. The capacity of the entire welding plant is such that eight welding operators may operate at the same time.

Throughout the plant both Westinghouse and General Electric motors have been installed and U-re-lite circuit breakers have been applied for protection. The lighting and power panels for distribution are of the Crouse-Hinds type made of ebony asbestos wood. Practically all of the wiring used was supplied by the Okonite Company of Passaic, while the lead covered cable was furnished by the Standard Underground Wire & Cable Company.

Installation of Flow Meters

The old problem of determining which department uses the greatest amount of steam or compressed air has been



Emergency Lighting Equipment Located in the Compressor Room

most satisfactorily settled as each line of piping leading out from the power house is equipped with General Electric flow meters which record the number of feet of compressed air or steam used by the different departments served from the plant. On the upper part of these flow meter panels is placed a recording chart each day which shows the period of maximum and minimum consumption and beneath these is located a meter which shows conclusively the exact amount of air or steam furnished over any specified interval of time.

The new warehouse of Heckers located near the Erie Jersey City passenger station and the Erie Grain Elevator situated back of Heckers are supplied with steam from this plant. The longest supply line at which steam is carried at high pressure from the plant is 2310 ft.

Lighting

The yard system of lighting consisting of incandescent series lamps is also supplied with current from the switchboard in the compressor room through a Westinghouse voltage regulator at 2300-volts.

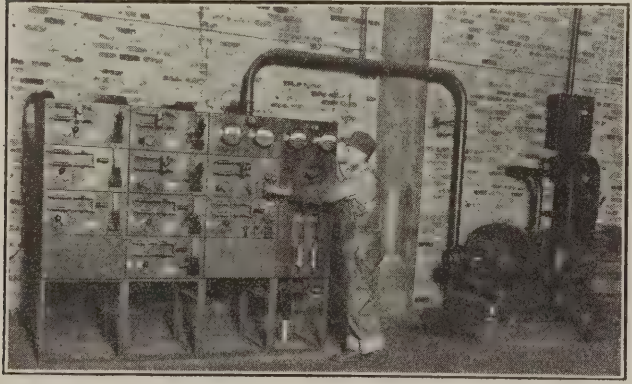
There is an emergency system of lighting installed in the power house as insurance against failure of purchased power. In the boiler room in a convenient location is situated a 1.kw. steam turbo-generator set which develops 110-volt direct current. Should any interruption of purchased power occur, the attendant would immediately start this machine which will furnish light to the boiler room and compressor room. As soon as this machine has been started and lights are available, a larger Westinghouse steam driven generator of 7½ kw. capacity is started and by making certain switching connections on the switchboard, this latter machine lights the entire power house until such time as the commercial source of power returns.

General

The erection of the new power house has been the means of replacing a number of smaller power plants scattered about the yard. These smaller plants were not nearly as efficient as the new one which is entirely modern in every respect and is showing marked economies over the old system of distributed units.

Battery Charging at St. Paul Union Depot

To provide suitable equipment to keep the storage battery baggage tractors in the St. Paul Union Station in proper operating condition, a small charging set has been installed. The motor-generator set consists of a



Charging Control Station Has Simple Ammeter Cut in Feature Incorporated in Each Knife Switch

G.E. 60-hp., 220-volt, 3-phase, Type KT-333 induction motor and a G.E. 42.5 kw., 85-volt d.c., 500-amp. generator. This is started through a G.E. Type CR-1034 compensator. A flexible control board with individual panels containing a knife switch, rheostat and circuit breaker for each of the charging circuits, is mounted against a brick partition, on the other side of which are located all of the charging receptacles,

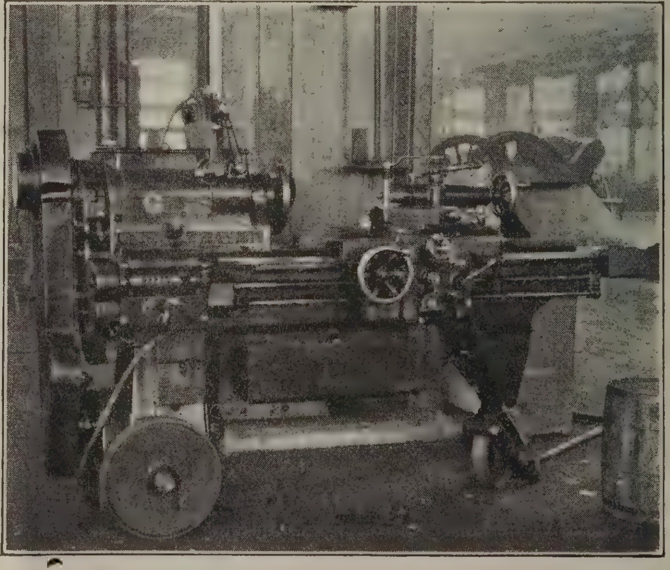
With this "Unipanel" charging control station, made by the Automatic Electric Devices Company, Cincinnati, Ohio, it is possible to insert the switchboard ammeter into any charging circuit by merely opening the double-pole knife switch until the blades come in contact with two auxiliary contact clips without opening the circuit.

The Noon Hour Line Up at the Filling Station—Each Charging Receptacle Is on a Separate Circuit

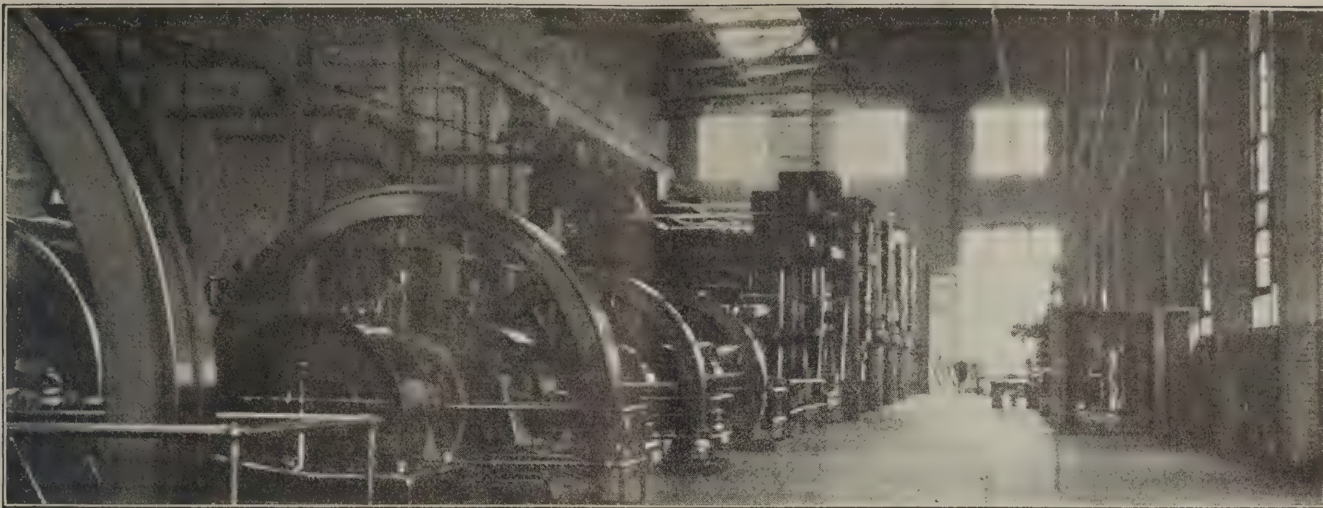
This has been found to be more satisfactory than the earlier panels of which two are still in use on this control board, requiring special ammeter switches. Each panel is rated at 85-volts, 90 amp. The master control panel at the right mounts the generator field rheostat and two Jewell indicating instruments, a (0-100) voltmeter and a (0-600) ammeter as well as a double-pole fused knife switch.

Nine charging receptacles are used, one on each circuit. They are Crouse-Hinds, Type GEE.

The American Railway Express Company announces that beginning next April it will be prepared to transport packages by airplane between New York and Chicago, and between Chicago and Dallas, Texas.



A Portable Lathe Used For Small Work in Erecting Shops



General View of the Interior of the Lehigh Valley Power House at Sayre, Pa.

Electrical Equipment on Lehigh Valley

Headlight Turbo-Generators for Entire System Are Overhauled and Repaired in Shops at Sayre, Pa.

AT Sayre, Pa., are situated the largest shops on the Lehigh Valley System. All of the electrical energy used in the shops is generated in the big power plant of the company which consists of 16 boilers of 305 hp. each, equipped with chain grate stokers, driven by 2 hp. d.c. motors. The power is generated at 440 volts, 2 phase by engine driven alternators and the necessary d.c. used in the shop is transformed by two rotary convertors.

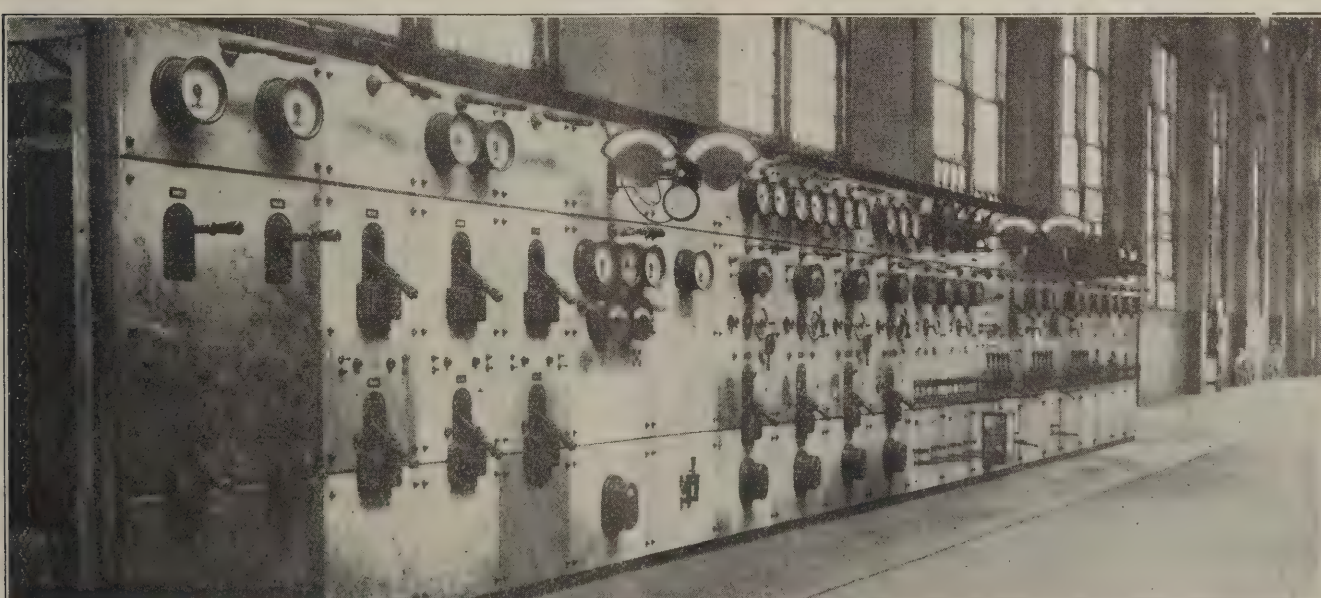
There are three engine generators rated at 750 kw. and one with a capacity of 400 kw. but it is not necessary to operate more than two of the larger units at one time.

From a switchboard in the power house the energy is transmitted to the main locomotive shop by underground cables laid in a terra cotta duct system, and to all of the other buildings, by means of an overhead pole line.

The 440-volt, 2 phase feeders carry current to all of the buildings for power service except some of the variable speed machines for which d.c. is used. The average monthly power generated by the plant is approximately 400,000 kw. hrs. at a cost of 5 mills per kw. hr., a figure which, however, does not include any overhead charge.

Motor Equipment

Throughout the shops there are located about 450 motors, both a.c. and d.c., varying in horsepower from ¼ to 200. All line shaft motors and motors for other



Marble Front Switchboard in Power House Which Controls All Electrical Energy Distributed to the Various Shop Buildings

power which do not require variable speed are operated from 440-volt, 2 phase circuits. There are, however, a great many of the machine tool motors which require speed control and these are supplied with direct current. This is true of all of the overhead traveling cranes.

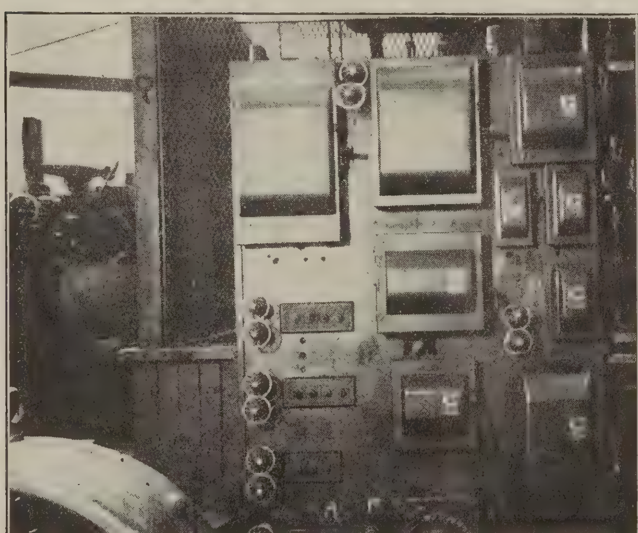
Repair Work

Not only are the motors of the shop maintained, but motors from other parts of the road are sent to Sayre for rewinding and general repairs.

All motors undergoing repairs are brought into the shop where they receive whatever attention is necessary, such as the installation of new bearings, new shafts or rewinding. If rewinding is necessary, the winding, after being painted is given a final insulation test of 1200 volts. All small armatures and motors are dipped in a good grade of baking varnish and baked for 24 hours. The large armatures and motors are sprayed with air drying varnish.

Testing Board

In testing the repaired equipment, a special test board has been devised which greatly facilitates this work.



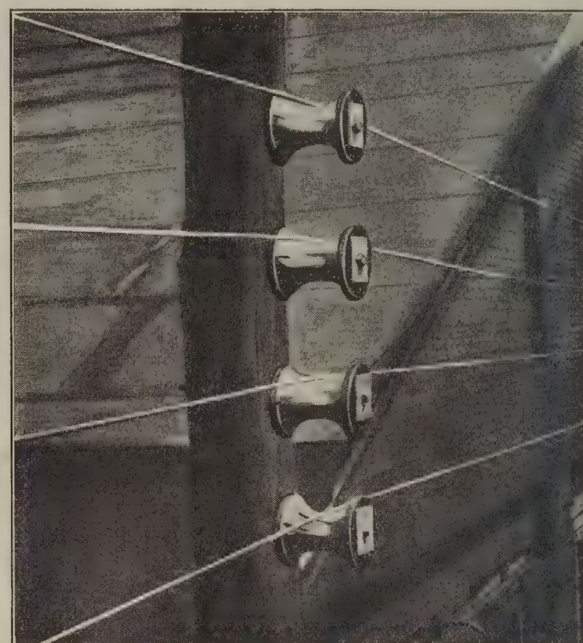
Testing Board Equipped With Numerous Controllers Where All Repaired Motors Are Given a Running Test

The board is so arranged that it is possible to get 440 volts, 2 phase; 220 volts, 2 phase; 220 volts, 3 phase; 110 volts, 220 volts, single phase; and 110 volts, 200 volts, direct current, so as to make it possible to put a running test on any motor that passes through the shop for repairs. Two phase power is used exclusively at Sayre shops although 3 phase equipment is used at some of the outside points.

Headlight Maintenance

Practically all of the headlight repair work for the entire system is done at Sayre. At each shopping of the locomotive all headlight generators are removed and taken to the electrical department for repairs. The parts, with the exception of the bearings, armature and coils, are taken from the generator and placed in a lye vat to insure thorough cleansing. Each part is then carefully inspected and reassembled on the generator which is put on test where it carries a load of 475 watts for a period of one hour. It is deemed necessary to give this rigid test on account of automatic train control which has recently been installed and which requires that the generator be in A-1 condition.

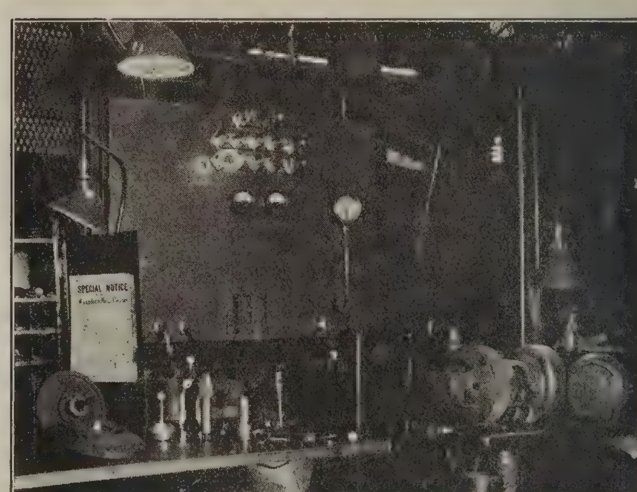
On account of the volume of headlight work that is continually going through the shop, special tools have been devised in order to handle a maximum of equip-



Unique Method of Supporting Trolley Wires Used at Transfer Table Pit. The Conductors Are Held Taut by Tension Applied at Ends of Run, But Rest Loosely as Shown, on Special Insulators on the Intermediate Supporting Poles

ment in a minimum of time. Piston governor valves and turbine wheels from all over the syetem are shipped to Sayre where they are carefully gone over and the good material salvaged and put back into stock.

A machine has been constructed for pressing out tur-



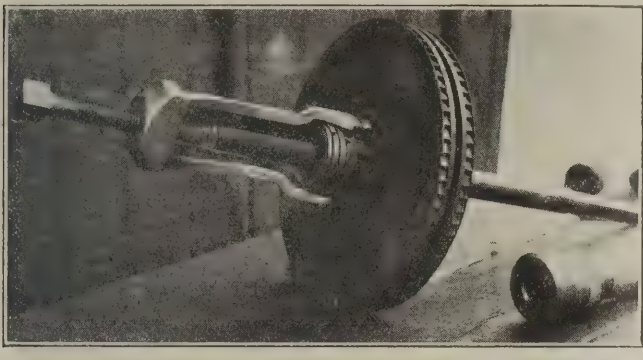
Headlight Testing Board and Workbench Where Turbo-Generators Are Overhauled and Tested

bine wheels and mounting wheels on new shafts and another device which has been developed in connection with this work is a machine for testing wheels for balance.

Special heads for attaching to plates on lathes have

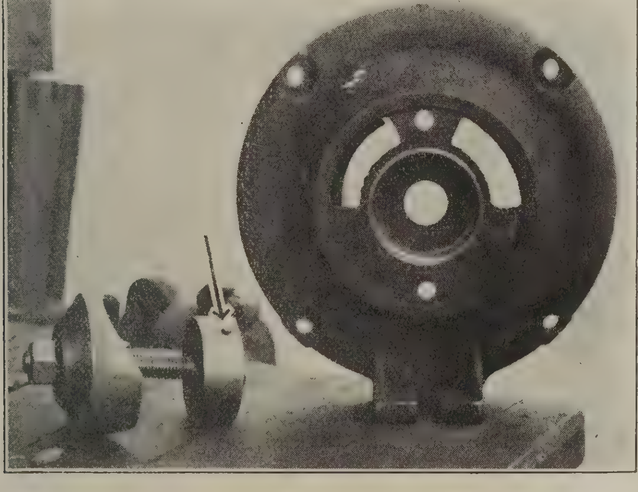
been made. These are used for rebushing the rear field frame and the turbine covers. A unique device for extracting ball bearing bushings greatly facilitates this operation and another extractor for removing the metallic packing used in the headlight generators is of great help. A companion to this latter tool is used for putting the packing on again.

All headlight armatures are repaired at Sayre. The complete overhauling of headlight turbo-generators is entirely on a production basis—piece work, at the rate of $2.25 per turbine overhauled.



Showing the Application of the Packing Puller. The Tool at the Right is Used for Driving the Packing On Again

In testing the turbines after repairs have been made, a steam pressure of 130 pounds is used which is the highest available. The load placed on the generator is practically the same as that which it receives in service on the locomotive. A bank of lamps is arranged on a test rack the same as on the locomotive. There are ten 15-watt lamps, one 250-watt lamp and one 100-watt lamp. The board is equipped with a steam gage as well as with a voltmeter and an ammeter which are controlled by switches. The generator is regulated so as to have not more than 2-volt difference from full load to light load.



The Tool at the Left is Used for Pulling Bushings from Ball Bearing Housings. The Pin Indicated by the Arrow is Compressed Towards the Center Against the Action of a Spring Until the Tool is Fitted Into the Bearing Bushing When the Pin Springs Outward Again Engaging With Holes in the Bushings Making it Possible to Pull the Bushing Out

After the final test has been made, the generators are given a coat of paint by spraying and are then ready to be returned to the locomotive.

Maintenance Force

All electric work, maintenance, repairs, construction, exclusive of car lighting, is taken care of by a force consisting of one foreman, 13 electricians, six apprentice boys, two promoted helpers and one helper.

Two of these electricians are on night duty which is divided into two shifts. These night men take care of all troubles that may come up at the power house, locomotive shop or round house.

There are five men working on headlights, three electricians and two apprentice boys. One of these electricians does all of the repairs to headlight turbines, both mechanical and electrical, and the other four men take care of all headlight work that consists of general overhauling.

One electrician and apprentice boy inspect and oil all of the motors and control equipment of the shop, once each week.

Three of the electricians are working in the shop, repairing and rewinding motors. This rewinding consists of all motors from outside points as well as those of the shop at Sayre.

Another electrician and apprentice boy have been assigned to equip locomotives with train control apparatus and when not on this work, they are engaged in heavy transmission line work. The G. R. S. train control intermittent inductive type is used.

One promoted helper who takes care of all lights in the shop and yards at this point, cleans and replaces bulbs, puts in fuses, etc.

The remaining three electricians, two apprentice boys and one promoted helper are separated into gangs to take care of all emergency work. These men do all repair work on wiring and take care of changes and new construction work.

Electric Freight Locomotive Tested on New York Central

ROAD service tests were made recently of a new 170-ton electric freight locomotive on the New York Central. It is one of an order of nine placed late in 1924, which included seven 100-ton switching locomotives and two 170-ton freight locomotives; these were described in the *Railway Electrical Engineer* of February 17, 1925. The freight locomotives consists of two articulated units, each one of which has a cab and two four-wheel trucks. Specifications required that the locomotives be capable of hauling a 3,000-ton train at 32 miles an hour and have a safe running speed of 60 miles an hour.

The test included three round trips between Harmon, N. Y., and High Bridge, N. Y., with a train made up of 100 cars weighing 3,006 tons. The total distance run was 144 miles. The train was made up of both loaded and empty cars and had three cabooses. One of these, coupled directly behind the locomotive, was equipped for measuring motor temperatures, voltage, current, power, efficiency and speed. The other cabooses carried engineers who watched the test and checked locomotive performance.

Three methods of measuring motor temperatures were used. These consisted of applying thermometers to the

motors, of measuring the resistance of the motor windings and of determining the temperature by means of special exploring coils placed in the armature slots and connected through slip rings to meters in the caboose. division; J. A. Carmody, superintendent of electrical equipment, and a crew of 24 of the electrical staff.

The locomotive, general dimensions of which are given in the table, was purchased from the American Locomo-

New York Central Type R Electric Freight Locomotive Hauling 3,000-Ton Test Train

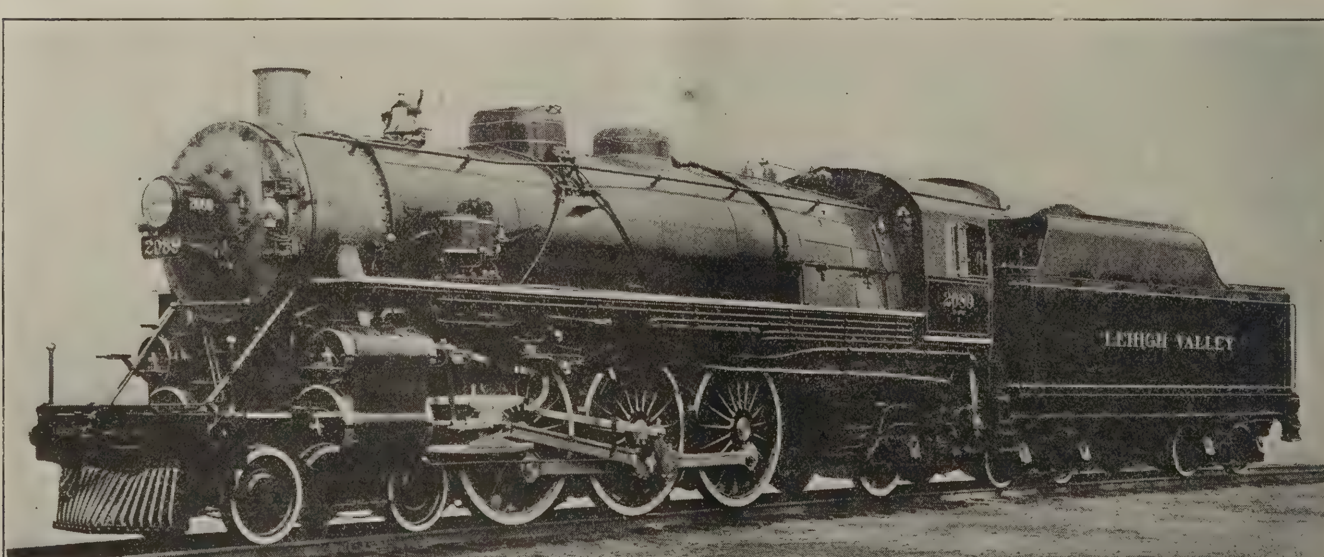
Temperatures by the first two methods were taken at the beginning and end of each run while temperatures by the exploring coil method were taken at regular intervals throughout the test. The tests showed that the locomotive was able to haul the specified tonnage without injurious heating. Previous tests made on the General Electric test track at Erie, Pa., showed that the locomotive could be operated safely at speeds above 60 miles an hour. The two freight locomotives will be used on the West Side freight tracks in New York City and their operation will probably be limited to the part of the line north of 72nd St.

H. A. Currie, assistant electrical engineer, New York Central was in charge of the tests and was assisted by J. T. Seaver, assistant engineer, electrical engineering

tive Company, equipped with electrical apparatus furnished by the General Electric Company.

General Dimensions and Specifications for New York Central Road Freight Locomotive

Wheel arrangement	0440-0440
Weight (All on drivers)	170 tons
Weight per axle	425,000 tons
Length, coupled inside knuckles	68 ft. 2 in.
Wheelbase, total	55 ft. 3 in.
Wheelbase, each unit	24 ft. 3 in.
Wheelbase, truck	8 ft. 3 in.
Width, over all	9 ft. 11½ in.
Height, trolley locked down	14 ft. 7 in.
Wheel diameter	44 in.
Curvature track (min.)	230 ft.
Locomotive to haul 3,000 tons at	32 m.p.h.
Maximum safe speed	60 m.p.h.
Ratings (blown, 120 deg., C-600 volt)	
Continuous T. E. locomotive	Speed
41,600 lb.	24 m.p.h.
28,400 lb.	35 m.p.h.
56,000 lb.	22 m.p.h.
Tractive effort at 30 per cent adhesion	102,000 lb.



A Resplendent Lehigh Valley Pacific

From Truck Mounted Generators to Body Hung

Chicago and Eastern Illinois Satisfactorily Solves a Problem in Equipping Old Cars With Electric Light

By J. H. Burcham
Chief Electrician, C. & E. I. Ry.

THERE is an undeniable tendency at the present time to convert truck mounted axle generators to body hung and for this reason, if for no other, the following article may be of interest to some of the readers of the *Railway Electrical Engineer.* This will be especially true to the fellows who are still operating Consolidated type-A equipment.

On the C. & E. I. we have some compartment mail and baggage cars which were lighted with oil and gas until about 2½ years ago when it was decided to light them by electricity. It so happened that we had some Consolidated type-A axle lighting generators on hand which we decided to use for this purpose, but when we examined the trucks of these cars (which were of the 4-wheel wooden type) we found that it was a difficult proposition to mount the generators on the truck. We then began to figure how we could hang them on the body of the car and as a result, we have devised a very satisfactory arrangement.

The suspension loops shown in the different illustrations are forged out of ¾ in. by 3 in. iron and shaped over a heavy iron form so that they are of exactly the same shape and size.

The iron blocks shown fitted between the two sides of the suspension loops are 3 in. thick, 4 in. wide and 6½ in. long. They were forged and planed down to these dimensions and are held in place by two ¾ in. turned bolts. The lower bolt passes through a tie strap which ties the top of the loops together and holds them in a parallel position.

The suspension loops could not be bolted to the bed plate of the generator directly without the loop at the commutator end preventing free access to the brushes, so we took a piece of ½ in. boiler steel of the same size as the bed plate of the generator, and bolted it to the bed plate, using the same holes which held the original short rocker shoe.

The bolts which hold the loop at the pulley end, pass through the loop and steel plate and into the same holes

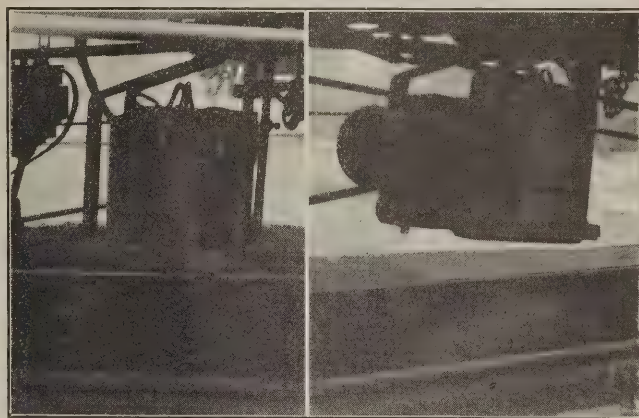


Fig. 4 Fig. 5
Two Views of the Equipment Applied and Belted

in the bed plate which hold the original extension rocker shoe.

The loop at the commutator end is located about the center of the pole changer hood. The steel plate is drilled and tapped and the loop is fastened to the plate by three ¾ in. cap screws.

Figs. 1, 2 and 3 show three different views of the ma-

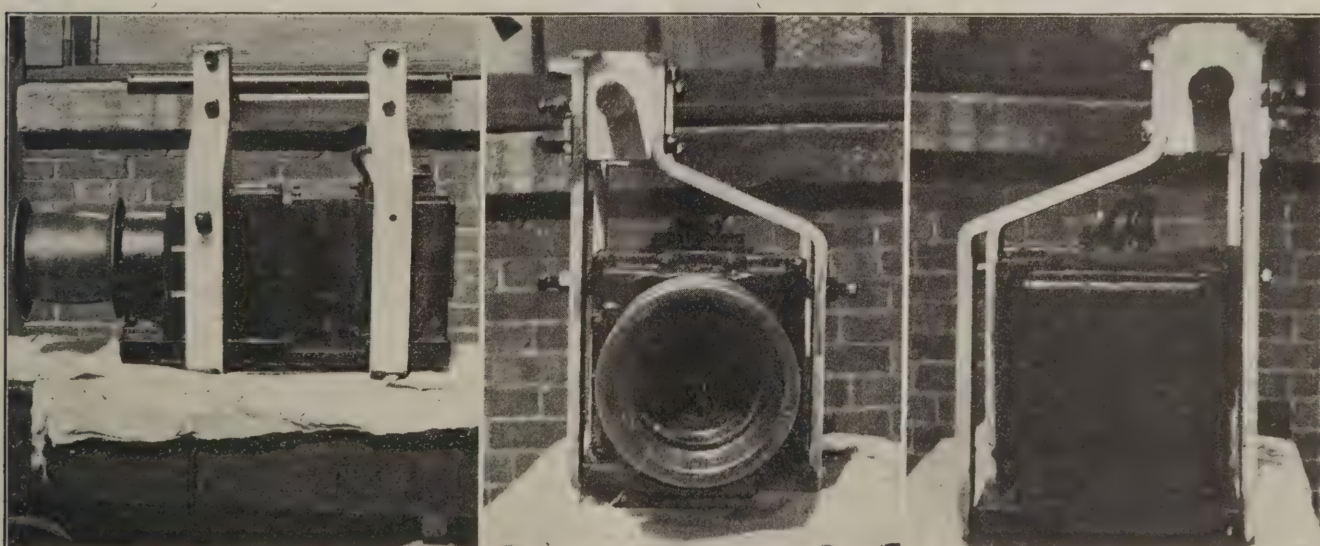


Fig. 1 Fig. 2 Fig. 3
Three Views of a Generator with Suspension Device Ready to Be Applied to the Car

chine ready for application to the car and Figs. 4 and 5 show it applied and belted.

In applying the machine to the car, it is first necessary to get the steel plate and have it bent to the proper shape to give belt clearance over the end sill and brake beam of the truck. It is then bolted or riveted to the underframing of the car. We use a plate ½ in. thick

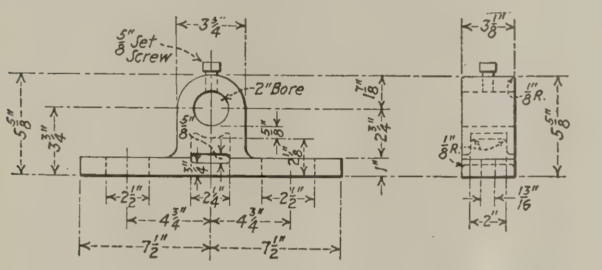


Fig. 6—Cast Steel Hanger Extensions

and 16 in. wide and to this plate we bolt two cast steel hanger extensions as shown in Fig. 6. These hanger extensions have slotted holes for aligning the generator. The generator is then raised to position and the suspension shaft inserted. We use a 2 in. shaft which is kept from turning in the hanger blocks that are attached to the suspension loops by two ¾ in. set screws. This

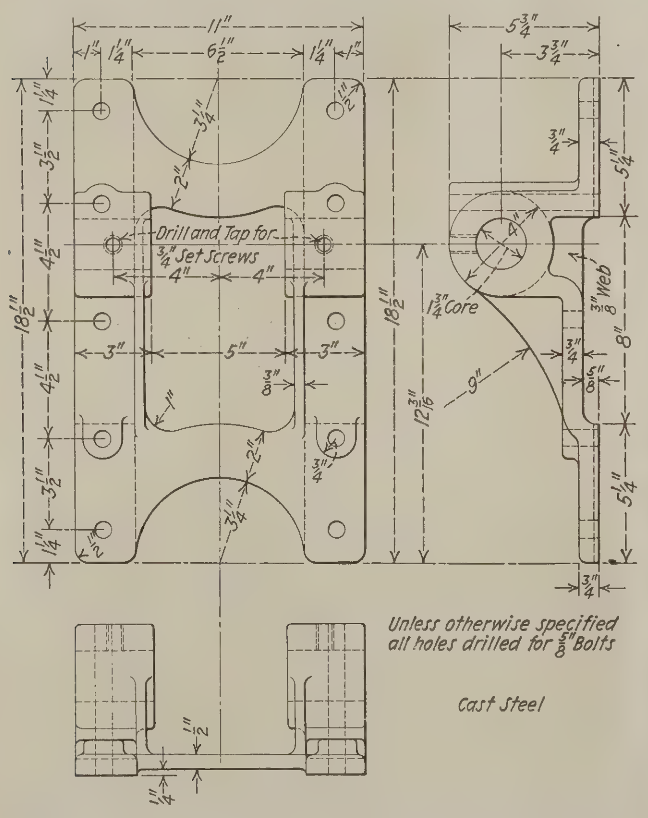


Fig. 7—Casting for Mounting Bliss Truck Hung Generators on Car Body

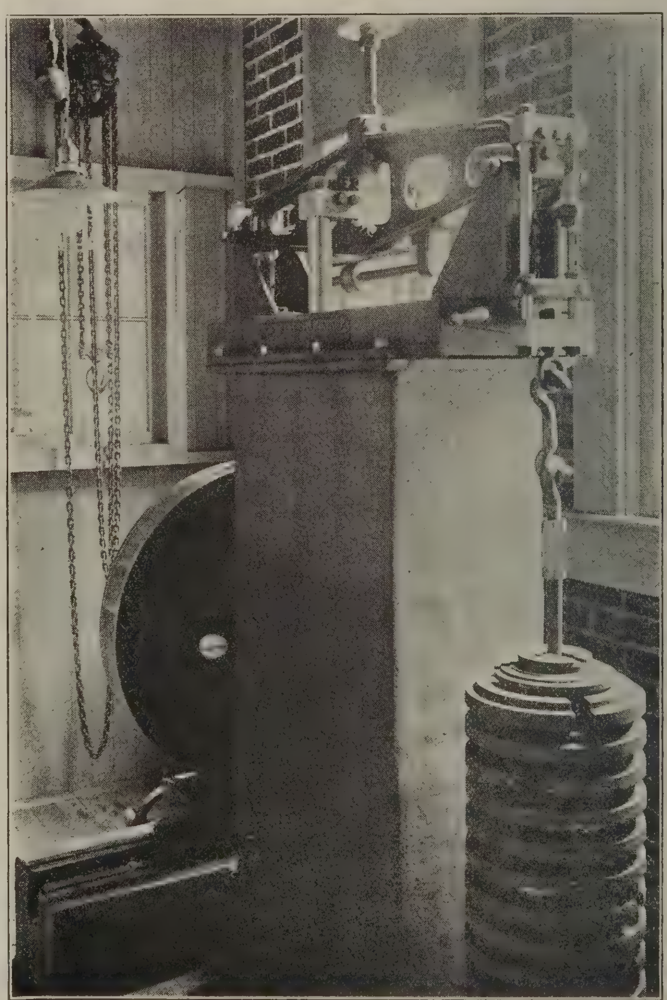
arrangement confines the wear entirely to the hanger extensions and shaft making it possible to change either or both with very little trouble.

Each machine is also equipped with two heavy safety chains, one end of these chains is attached to the suspension loops by an eye bolt and the other end is attached to the suspension plate in the same manner.

I might say that with the generators suspended in this fashion, we get as good or better belt mileage than we get from our truck mounted generators. Several years ago we applied ball bearings to all of our Consolidated generators and discarded the old regulators, replacing them with Safety F-1 regulators so that at the present time we feel that we have a really first-class 1-kw. equipment.

I might further say that we suspend our Bliss truck hung generators to the body of the car in a similar manner. We get out a cast steel casting as shown in Fig. 7. The generator is turned bottom side up, and this casting is bolted to the legs of the generator, using the same holes that are in the generator legs. The machine is then hung to the car in exactly the same manner as the Consolidated type-A, using the same hanger casting on the car in both cases.

It will be noted that we have no belt tension spring in either case, the machine being hung out of center, puts the weight of the machine against the belt and gives us sufficient belt tension at practically any season of the year without causing any trouble whatever from belt slippage.



Car Wheel Scales at Purdue University—A Delicate Balance Affords a Means of Recording a Very Small Loss in Weight of the Wheel After Brake Shoe Applications

Train Control on the Union Pacific

Thorough Training of Enginemen Together with Careful Inspection of Equipment Shows Excellent Results on 225 Miles of Line

THE Union Pacific fulfilled the requirements of the first train control order of the Interstate Commerce Commission, by placing in service on June 1, 1925, a system of two-speed continuous train control on 102 miles of its double track main line between Sidney, Nebr., and Cheyenne, Wyo. This same system of train control as manufactured by the Union Switch & Signal Company, was extended eastward from Sidney, Nebr. to North Platte, Nebr., a distance of 123 miles and placed in service on February 1, 1926.

Equipment Box Open Ready for Megger Test. Governor and Drive Require But Little Attention in Regular Service

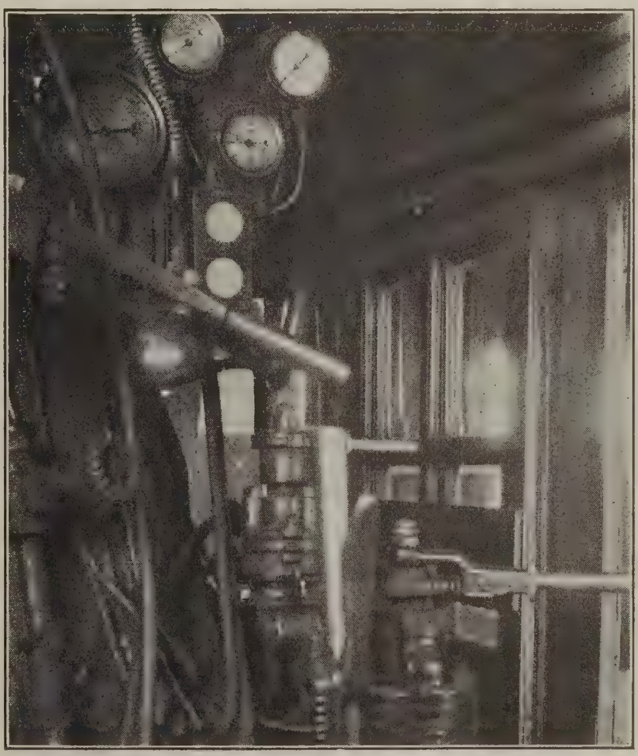
For the first district equipped with train control, Sidney, Nebr., to Cheyenne, Wyo., 100 engines were equipped for train control operation. Passenger engines are operated straight through from Omaha to Cheyenne, 509 miles; freight engines from North Platte to Cheyenne, which includes both the first and second train control territories. Therefore, for the second order it was necessary to equip only 31 additional engines, including passenger engines operating between Omaha and Denver via Julesburg, and the freight engines for the Denver to North Platte run; also the freight and passenger engines for the North Platte Branch, 16.2 miles of which is on the main line.

The Training of Enginemen

In order to eliminate unnecessary delays to train operation on account of train control. special attention was given to instructing the enginemen concerning the operation of the train control, before the equipment was cut in for regular service.

An engineman on the Union Pacific, who had been following the development of train control quite closely, was appointed as train control instructor. Beginning seven months before the first equipment was placed in service, this instructor conducted schools at the various engine terminals. By means of charts, samples of the equipments, etc., explanations were presented, until all of the enginemen and firemen had been afforded an opportunity to learn the fundamentals of the system. By that time many of the engines were equipped, and the instructor accompanied enginemen on their runs, until all had received actual road operation instruction before the installation was placed in service.

In order to operate trains under train control protection without unnecessary delays, the engineman must be familiar with the following performance: Under normal operating conditions in a clear block, a green light in the cab indicator is lighted. In case a signal is at stop, this cab signal indication changes from green to red when the engine passes the "B" point, which is braking distance from the stop signal. In order to prevent an automatic application of the brakes, it is necessary that the engineman operate the acknowledging lever and start a manual reduction of brake pipe pressure sufficient to apply the brakes and reduce speed below 20 m.p.h. This application may be made by split reductions, but must total 22 lb. reduction in brake pipe pressure, otherwise an automatic application will follow.



Special Air Gage Mounted Above Two-light Cab Signal. Note Small Acknowledgment Lever to Left of Engineman's Brake Valve

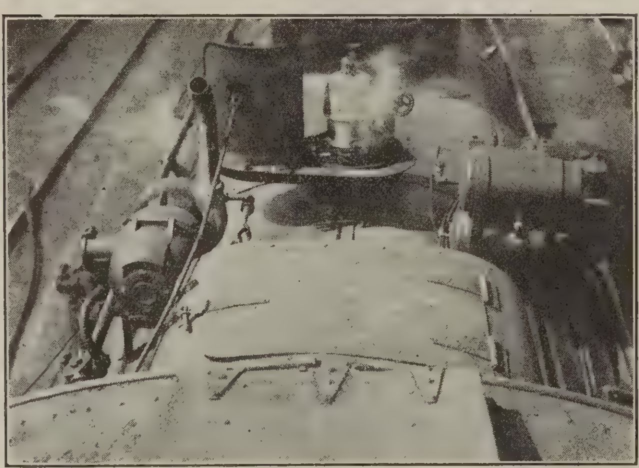
If the engineman should be incapacitated, or for any

other reason should fail to take action to acknowledge and apply the brakes within 5 sec. after the change from green to red in cab indication, if the speed is over 35 m.p.h., the brakes are applied by an automatic reduction of brake pipe pressure by split reductions totaling 22 lb. for freight service and 30 lb. for passenger service. This application results in the train being stopped.

In case the engineman acknowledges the change in cab indication, from green to red, and reduces speed to below 20 m.p.h., he may proceed through the block at 20 m.p.h. Should the speed of 20 m.p.h. be exceeded in a stop block, the brakes will be applied automatically. However, the Union Pacific has not made any change in the automatic block signal rules, therefore the engineman is required to stop at the signal indicating stop. He may then enter the block at a speed not to exceed 6 m.p.h. being prepared to stop short of a train or obstruction in the block.

If, while running in a stop block, the red indication of the cab signal should change to green, indicating that the block is clear, the engineman continues at a speed of less than 6 m.p.h. for a train length and then he may resume normal speed through the block. The purpose of keeping the speed reduced for a train length is to insure that if the train passes over a broken rail, which might have been the cause of the danger indication, the entire train would then be beyond the break before normal speed is resumed.

If a switch should be thrown, or a car should drift out of a siding over the fouling point in a block ahead of an approaching train, the cab indication would change



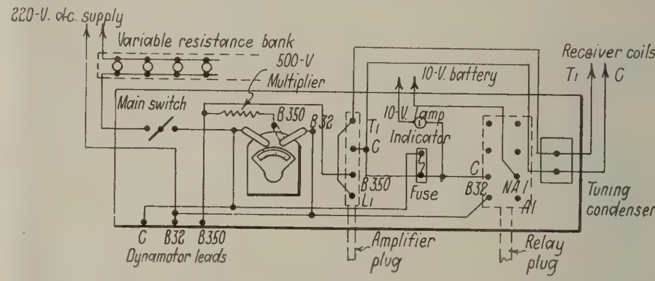
View from Top of Cab with Train Control Valve Group and Limiting Reservoirs Right and Special Turbo-Generator at the Left

from green to red and the brakes would be applied automatically unless the engineman took action within 5 sec. to acknowledge and start to reduce the brake pipe pressure as explained in a preceding paragraph.

In case of an automatic brake application, the engineman should lap his valve, otherwise the automatic application will not stop at 22 lb. or 30 lb., but will exhaust the brake pipe pressure to zero. Having received the automatic application and lapped his brake valve, the engineman of a passenger train can recharge his brake pipe when the speed has been reduced below 20 m.p.h., thus releasing the brakes and permitting train to proceed with caution at a speed under 20 m.p.h.

Engineman Tests Automatic Train Control Before Leaving Terminal

Although the train control equipment is thoroughly tested at the roundhouse, the engineman makes three tests himself. At North Platte, Sidney and Sterling, where engine crews are changed, the tests are made as follows: After the passenger train has been inspected, the air men call for a train brake test, the engineman reverses the cut-out switch in the cab, which is equivalent to entering an occupied block, thus changing the



Automatic Train Control Test Panel for Checking the Operation of the Electrical Equipment on the Locomotive

cab indication from green to red and initiates an automatic brake application. In view of the fact that the engine is standing still, the maximum delay time of 40 sec. is effective, and during that period, the engineman proceeds to make a brake pipe reduction of 22 lb., thus suppressing and preventing an automatic application. This operation checks the equipment and informs the engineman that he can take charge of handling of the brakes himself if he is alert when a change of indication from green to red occurs on the road.

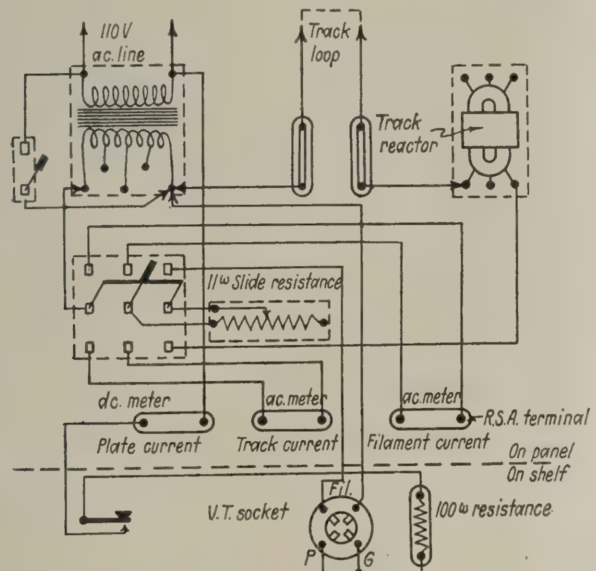
After all of the car men are out from under the train, the engineman proceeds to make two other tests, to ascertain if the apparatus will function to apply the brakes. With the equipment in the normal position, and a green light showing, the engineman again reverses the cut-out switch; and allows the automatic application to complete its cycle, noting the operation of the gages and apparatus. With the apparatus set up normal, the engineman again reverses the cut-out switch, changing the green indication to red. This time he acknowledges the change by moving the acknowledgment lever, thereby preventing the automatic application in view of the fact that the engine is not traveling at a speed of over 20 m.p.h. The last two tests are made after the train is otherwise ready to depart. The same three tests are made by enginemen at Cheyenne, on the outgoing track. Also all freight engines leaving North Platte are tested as outlined above.

Special Cut-out Features

Every train operated between North Platte and Cheyenne has train control protection. If a non-equipped engine is run over this territory, it is double-headed behind an equipped engine. In case the train control equipment on the engine fails on the road in a manner that cannot be repaired by the engineman, he is required to run at a speed under 20 m.p.h. until he arrives at a point of communication, where he advises the dispatcher, who is the only person having authority to issue an order to cut out the train control equipment.

The application valve group is equipped with a Yale

lock made for two keys. One key is carried in a holder in this group. To cut out, the engineman inserts this key and turns it, permitting him to operate the cut-out lever. The engineman cannot remove this key, it remaining in the lock as an indication that the equipment was cut out, until the inspector at the roundhouse inspects the engine, at which time he uses his master key to remove the engine key. If, after the engine has been cut out, the engine or wayside apparatus is repaired and placed in service, the engineman can again cut in the engine apparatus and proceed under train control protection.



Test Panel for Track Circuit Supply and Emission Test of Vacuum Tubes

Eastbound passenger engines which operate through from Cheyenne and Denver to Omaha, are cut out electrically and manually by the inspector at North Platte, where the engine crews change. Likewise, westbound passenger engines are cut in service at North Platte. Engines leaving the main line train control territory at Julesburg, to pass onto the Denver line are cut out electrically after leaving the main line, by means of the engineman reversing the cut-out switch while passing over a highly energized loop. The engine runs under this high speed cut-out to Sterling, Colo., 57.5 miles, where the apparatus is cut out manually before the engine departs for Denver.

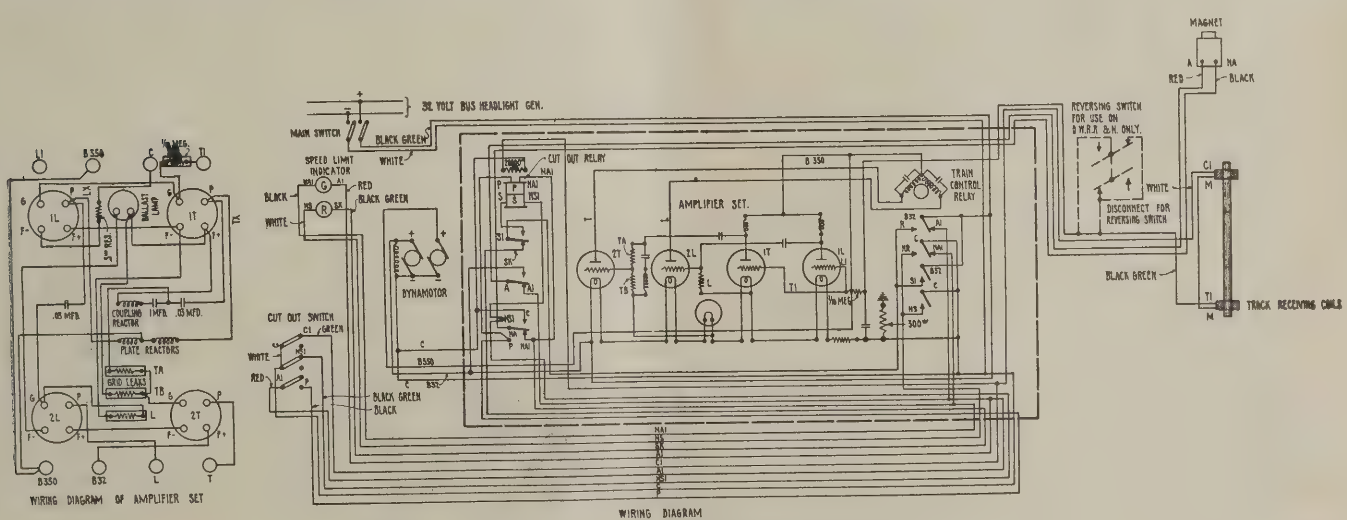
The engines operating over the North Platte Branch are cut out manually at O'Fallons. All eastbound engines entering train control territory at O'Fallons are locked in service by the agent at that station, before proceeding to the main track.

After Trip Operating Test at Roundhouse

Upon the arrival of each engine at the inbound track at the roundhouse, the electrician and the pneumatic men co-operate in making the after trip operating test of the train control equipment. The electrician makes an electrical resistance test of the wiring, by means of a Megger tester. This reading should be over one megohm on all circuits, including lighting circuits. By means of this test, ground in light sockets, field coils of the generator, etc., are located and removed before causing trouble with the train control operation. The headlight voltage is checked to see that it is not over 34 volts nor under 30 volts. In order to insure satisfactory operation of train control equipment, all passenger engines have been equipped with Pyle-National Type E-3 or MO-6, and, in a few cases, Keystone turbo-generators.

The next step is to check the operation of the train control relay, which is accomplished by varying the track circuit feed of the test loop. All relays are operating on from 250 to 270 m.a. pick-up; from 300 to 320 m.a. full stroke, and from 220 to 200 m.a. release. The high speed cut-out relay is tested by increasing the track current in the test loop from 3.4 amp. to 4 amp. All terminals are then checked over to insure that they are tight and no wires broken in the instrument case.

The Automatic Train Control air man makes his tests at the same time, proceeding as follows: The delay time on the apparatus between change of indication and automatic application is checked which should be from 34 to 44 sec. The next step is to check the long release time, which runs from 35 to 40 sec. and the short time release which should be 4 sec. He also checks the suppression, automatic application acknowledgment features and that the correct brake pipe reduction is made by the

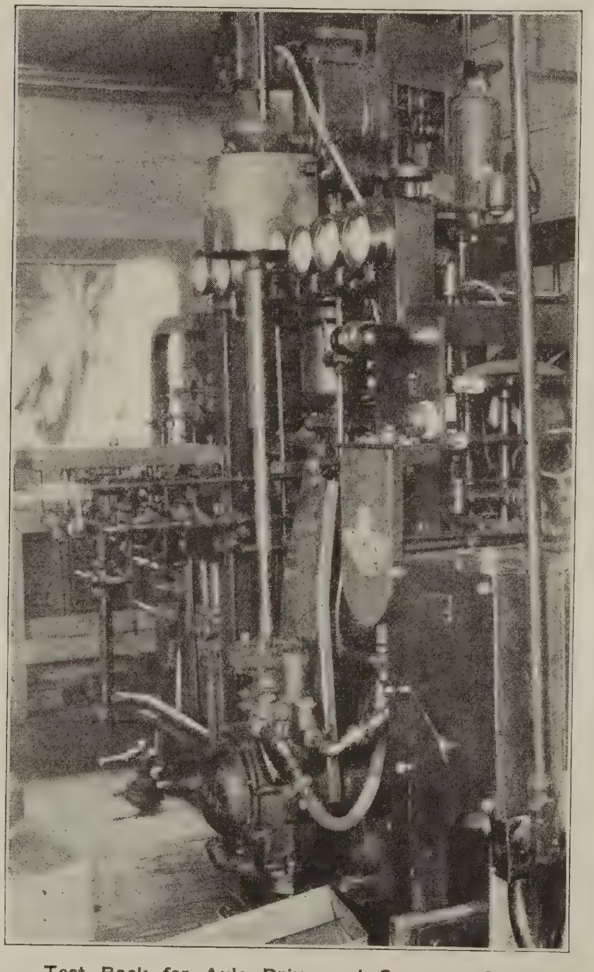


Wiring Daigram for Engine Equipment

automatic feature. The gages are checked to ascertain that the proper pressures are carried in the train control apparatus. All pipes are then checked for leaks, and all pipes and brackets are inspected to see that they are tight. A report of this test is made, as shown in the accompanying illustration, a copy being kept as a record. Any trouble indicated by these inbound tests is located and corrected in the roundhouse. Complete detail tests are again made by both the electrician and air man when the engine is on the departure track and ready for service.

Monthly Inspection and Test

All engines are held in the roundhouse for a complete mechanical and electrical inspection once a month. All electrical apparatus, including the headlight and train control equipment is thoroughly inspected. The engine relay and amplifier units are taken to the shop and cleaned and tested. The amplifier tubes are given an emission test. All tubes reading under 25 m.a. are removed from service. The average life of tubes is 1,700 burning hours. The tubes are marked and replaced in the same position, to keep the values the same. After all equipment is assembled, a monthly inspection test is made and a report filled out. These reports are filed for reference at any time.



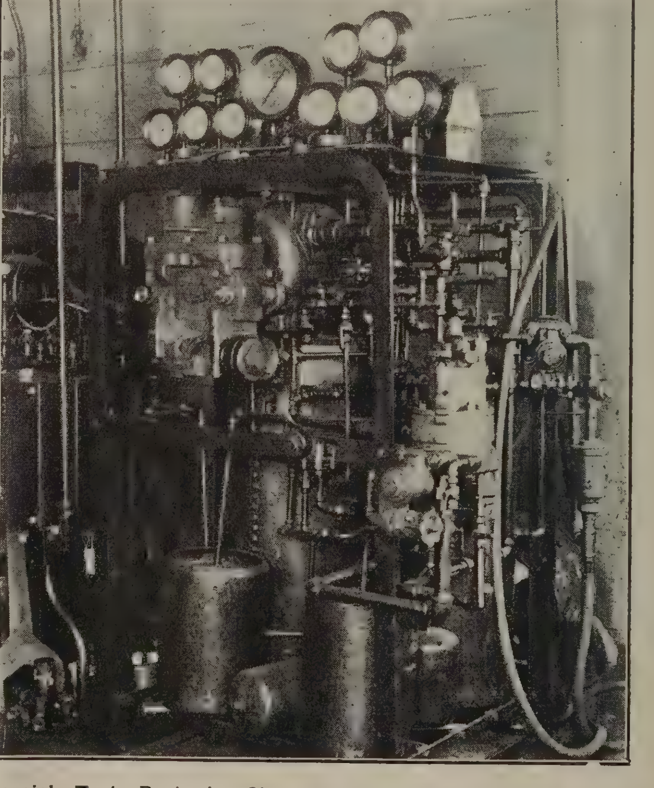
Test Rack for Axle Drive and Governor Group

The pneumatic maintainer removes the application valve portion, relay portion and engineman's brake valve, which are taken to the shop for cleaning and oiling. The protection governor and axle drive are also cleaned and oiled. All of the train control piping on the engine is blown out to remove any accumulated dirt or pipe scale. The air gages are removed and tested. The feed valve is cleaned, and the safety pop valve on No. 1 pipe line is tested. The relay brake pipe vent valve and pressure maintaining feature are also cleaned at this period. The apparatus is then assembled and tested and a record kept on a suitable form.

The Electrical Equipment of the Train Control System Is Removed from the Engines and Sent to Omaha Shop for Overhauling Periodically

Periodical Overhauling and Heavy Repairing

If any trouble develops on the engine relay, or amplifier unit, this apparatus is shipped by baggage in special shipping cases to the Omaha signal shop, where special testing and repair equipment has been provided. At scheduled intervals, this equipment is sent in for inspec-



Special Test Rack in Cheyenne Shops for Testing Detail Operations of Train Control Valve Group

tion and cleaning, whether trouble has developed or not. At the signal shop, units are completely torn down, the condensers tested and the relays overhauled and adjusted. They are then returned to the point from which received.

At Cheyenne shops, a special pneumatic test rack has been provided for testing the pneumatic train control equipment. The government drives on all engines are removed and given a general inspection and overhauling about every four months. The device is then placed on the test rack and given an operating test to see that all valves are operating properly before being applied to an engine or held for future use. In case trouble develops on any of the other pneumatic equipment at any terminal, which cannot be readily repaired, the equipment is sent to the Cheyenne shop where complete tests are made on the test rack, and the equipment is repaired.

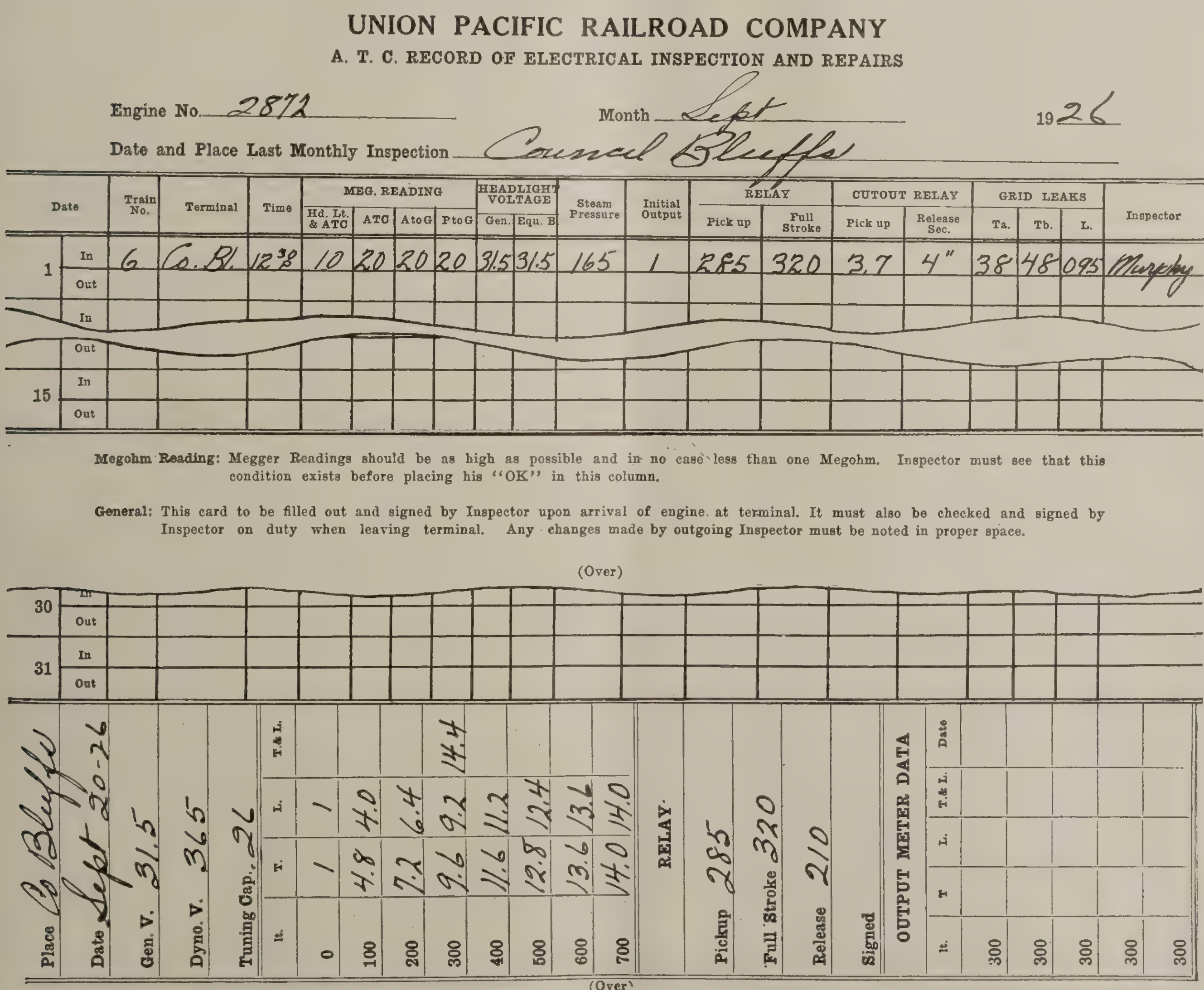
Maintenance of Engine Apparatus

Train control maintenance is handled at four engine terminals; Council Bluffs, Ia., North Platte, Nebr., Cheyenne, Wyo., and Denver, Colo. The inspection and running repairs to engine equipment has been incorporated in the duties of regular roundhouse electricians and air brake maintainers. A signal inspector was used

MONTHLY REPORT OF AUTOMATIC TRAIN CONTROL PERFORMANCE

	Sidney to Cheyenne 102 miles double track 1925						North Platte to Cheyenne 225 miles double track 1926					
	June	July	Aug.	Sept.	Oct.	Nov.	Feb.	Mar.	Apr.	May	June	July
Number of engines in service	64	69	72	92	76	88	88	88	94	95	94	96
Number of trips with device cut in	897	1,138	1,266	1,569	1,999	1,461	1,254	1,496	1,486	1,429	1,429	1,597
Number of trips with device cut out	3	1	1	2	4	4	3	21	13	7	6	17
Number of failures	9	7	8	7	8	9	12	13	12	16	27	27
Failures—engine equipment	7	5	5	6	7	7	9	7	12	10	7	11
Failures—roadside	2	2	3	1	1	2	3	5	1	6	20	16
Number of undesirable stops account of above failures—engine equipment	...	5	5	6	7	7	9	7	12	10	7	11
Number of undesirable stops account of above failures—roadside	7	3	7	5	3	3	5	†18	1	‡18	‡33	‡28

† Undesirable stops due to short circuit on 2,300 volt line. ‡ Undesirable stops due to lightning trouble.



UNION PACIFIC RAILROAD COMPANY

A. T. C. RECORD OF ELECTRICAL INSPECTION AND REPAIRS

Engine No. 2872 Month Sept 1926

Date and Place Last Monthly Inspection Council Bluffs

Date		Train No.	Terminal	Time	MEG. READING Hd. Lt. & ATC	ATC	AtoG	PtoG	HEADLIGHT VOLTAGE Gen.	Equ. B	Steam Pressure	Initial Output	RELAY Pick up	Full Stroke	CUTOUT RELAY Pick up	Release Sec.	GRID LEAKS Ta.	Tb.	L.	Inspector
1	In	6	Co. Bl.	12:30	10	20	20	20	31.5	31.5	165	1	285	320	3.7	4"	38	48	095	Murphy
	Out																			
	In																			
	Out																			
15	In																			
	Out																			

Megohm Reading: Megger Readings should be as high as possible and in no case less than one Megohm. Inspector must see that this condition exists before placing his "OK" in this column.

General: This card to be filled out and signed by Inspector upon arrival of engine at terminal. It must also be checked and signed by Inspector on duty when leaving terminal. Any changes made by outgoing Inspector must be noted in proper space.

(Over)

30	In																			
	Out																			
31	In																			
	Out																			

Place C. Bluffs

Date Sept 20-26

Gen. V. 31.5

Dyno. V. 36.5

Tuning Cap. 26

It.	0	100	200	300	400	500	600	700
T.	1	4.8	7.2	9.6	11.6	12.8	13.6	14.0
L.	1	4.0	6.4	9.2	11.2	12.4	13.6	14.0
T. & L.				14.4				

RELAY

Pickup 285

Full Stroke 320

Release 210

Signed

OUTPUT METER DATA

It.	300	300	300	300	300
T.					
L.					
T. & L.					
Date					

(Over)

Inserts Clipped from the Two Sides of the Engine Test Record Card Which Is Carried in Holder on Engine

for the special training of these men, and for the inspection of the equipment in service. Special schools of instruction were conducted at all four terminals mentioned, to teach the electricians and air brake men the

A. T. C.

UNION PACIFIC RAILROAD COMPANY

AFTER TRIP OPERATING TEST

Engine No. 2872 Date Sept 7 1926
Left Co Bluffs At M
Arrived at M. Tested by Williams

		Train Control Load	Full Load
1. Headlight generator voltage as found		32	31
	As Left	32	31

2. Steam Pressure 195 Pounds.

	As Found	As Left
(A) Main Reservoir Pressure	110 lbs.	110 lbs.
Brake Pipe Pressure	90 lbs.	90 lbs.
(B) Blow-down Res. Pressure	70 lbs.	70 lbs.
Pipe 4 Line Pressure	70 lbs.	70 lbs.

(B) Delay Time 42 Seconds
(C) Did Brakes Apply? yes
Brake Pipe Reduction 29 Pounds
(D) Was Split Reduction Obtained? —
4. Short Release Time 4 Seconds
5. Long Release Time 36 Seconds
6. (B) Was Automatic Application Suppressed? yes
(C) Was Automatic Application Avoided when Brakes Were Released? yes
Stop Reservoir Pressure 70 Pounds
Acknowledging Time 61 Seconds
7. (B) Did Delay Start? no
Did Cab Signal Remain Green? yes
(C) Did All Lights Go Out? yes
Did Blow-down No. 15 Reservoir Pressure Build up to 70 Pounds? yes
8. (B) Did Cab Indication Change from Green to Red? yes 4"
REMARKS:

Note:—Report on this Form, under REMARKS, all defects and corrections on pneumatic equipment. Also show work performed and material used.

Successful Operation of Train Control Depends on the Consistent Maintenance, and the Incoming Test Serves to Anticipate and Eliminate Trouble

fundamentals of the train control equipment. These schools were held during the day on company time. During this period, three experienced signalmen were assigned as train control adjusters, to assist the electricians inspecting the engines at roundhouses. After the train control had been in service for about one year, these men were returned to their regular signal duties.

List of the Present Personnel for Maintenance of Engine Equipment

Cheyenne, Wyo.		
First trick	1 Leading ATC Machinist	8 hours
	1 ATC machinist on axle drive equip	8 "
	1 ATC machinist test equipment	8 "
	1 ATC machinist	4 "
	1 ATC electrical specialist	8 "
	1 ATC electrician	4 "
Second trick	1 ATC machinist	6 "
	1 ATC electrician	8 "
Third trick	1 ATC machinist	6 "
	1 ATC electrician	8 "
Sidney, Nebr.		
	1 ATC electrician	4 "
North Platte, Nebr.		
First trick	2 ATC machinists	8 "
	1 Electrician leader	4 "
	1 ATC electrician	8 "
Second trick	1 ATC machinist	4 "
	1 ATC electrician	8 "
Third trick	1 ATC machinist	4 "
	1 ATC electrician	8 "
Council Bluffs, Ia.		
First trick	1 ATC machinist	6 "
	2 ATC electricians	4 "
Second trick	1 ATC machinist	6 "
	1 ATC electrician	4 "
Third trick	1 ATC machinist	6 "
	1 ATC electrician	4 "

A. T. C.

UNION PACIFIC RAILROAD COMPANY

MONTHLY INSPECTION

Test of Engine No. 2892 at Cheyenne Date 6-3-26 By TR

MEGGER READING

Train Control 30
Headlight 10
Headlight and Train Control 10
Headlight Generator Voltage 32
Dynamotor Voltage 360

CONDENSER VALUES

Track 26

INPUT-OUTPUT DATA

Track Input	0.0	Output	Track	1	Local	1
" "	.10	"	"	4.0	"	5.2
" "	.20	"	"	6.4	"	8.4
" "	.30	"	"	8.4	"	10.6
" "	.40	"	"	10.2	"	12.4
" "	.50	"	"	11.6	"	13.2
" "	.60	"	"	12.6	"	13.6
" "	.70	"	"	13.2	"	14.2

TRACK CURRENT

Pick-up 250
Full Stroke 315
Release 220

PHASE ANGLES

Input .30 T 8.4 L 10.6 T+L 16.0

CUTOUT RELAY

Pick-up Value Track Current 3.8
Release Time 4

GRID LEAKS

Megger Resistance Ta 32 Tb 75 L 45 (See Instructions)

TUBES

Number 1T 6185 2T 1495 1L 6395 2L 1473

RECEIVER COIL

	Left	Right
Height	6"	6¼"
Number		

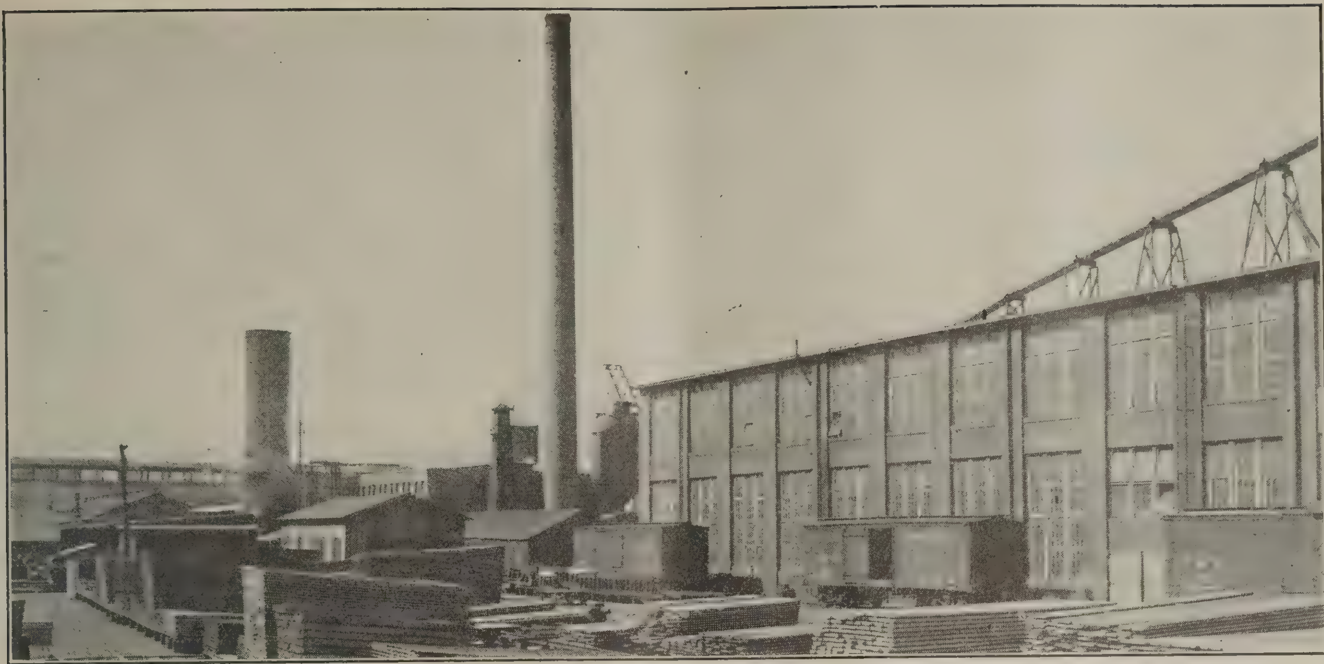
EMISSION TEST

1-T 38 1-L 35 2-T 40 2-L 50

Form for Monthly Inspection Report of Electrical Apparatus

Denver, Colo.		
First trick	1 ATC machinist	8 "
	1 ATC electrical specialist	8 "
Second trick	1 ATC machinist	2 "
	1 ATC electrician	4 "
Third trick	1 ATC machinist	2 "
	1 ATC electrician	2 "

Delaware, Lackawanna & Western.—This company and its subsidiary, the Morris & Essex, have been authorized by the Interstate Commerce Commission to construct 0.68 miles of 4-track line in Jersey City, N. J., in connection with a new freight terminal to be built there. It is planned to utilize motor trucks in the under-Hudson vehicular tunnels now under construction for freight service to and from New York, which necessitates an increase in facilities at Jersey City. The new terminal will be a two-level structure constructed to permit later the addition of several stories for warehouse purposes above it. The new track to be built for connection with the terminal will be above the street level, necessitating several steel bridges. The estimated cost of the entire project, of which 50 per cent will be constructed in the initial stage, is placed at $12,938,000.

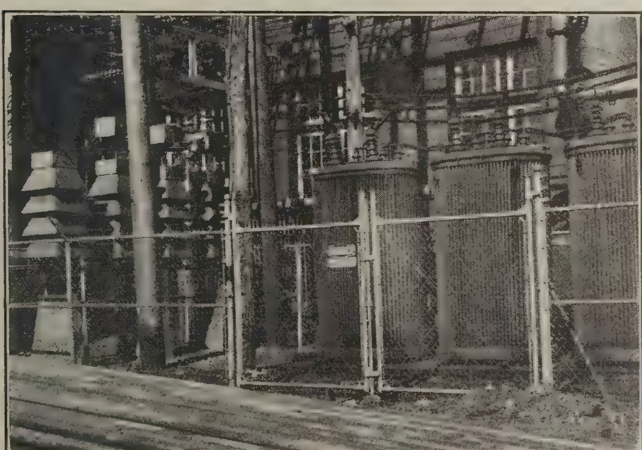


General View of Lumber Yard and Planning Mill With Power House in Distance

Chesapeake & Ohio Shops at Huntington

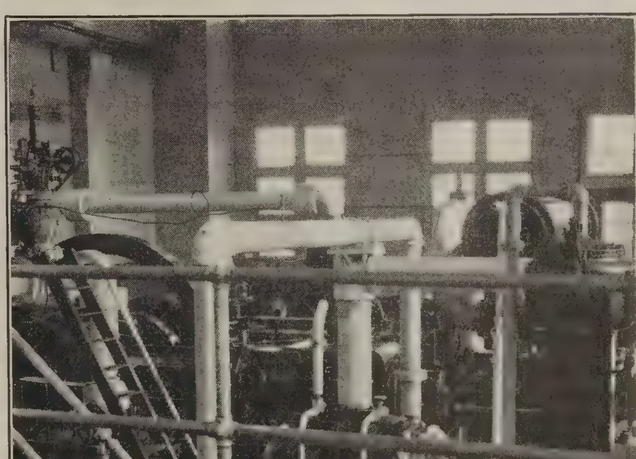
Company Both Generates and Purchases Power—Tendency to Increase the Latter Due to the Low Cost of Purchased Electric Power

AT Huntington, W. Va., the Chesapeake & Ohio operates one of the largest shops on its system. Both purchased power and steam power are used at the present time, although it is anticipated that in the near future all of the electric power that is required at this point will be purchased. From 750 to 1,000 kw. is generated and from 900 to 1,200 kw. purchased.



Transformers and Lightning Arresters Where Electrical Energy Is Received from Commercial Source

For the present, however, the power house equipment consists of six Stirling water tube boilers, all fired by double retort mechanical underfeed stokers. The stack on the boiler house is 205 ft. in height and forced draft is also used. The installation of the underfeed stokers has only recently been added to the power house and in conjunction with it, there has been installed a coal crusher and skip hoist for crushing and transferring coal from the cars directly to the boiler room, where it is dumped into a traveling weighing larry and carried to the coal hoppers over the grates by means of electric power. A steam jet ash conveyor delivers ashes from boilers to overhead ash hoppers and by gravity to ash car on siding. These improvements cost approximately $30,000 for the stokers, $19,000 for the coal equipment and



Compressor Section of the Power House—Two Steam Driven and Two Motor Driven Compressors Are in Use

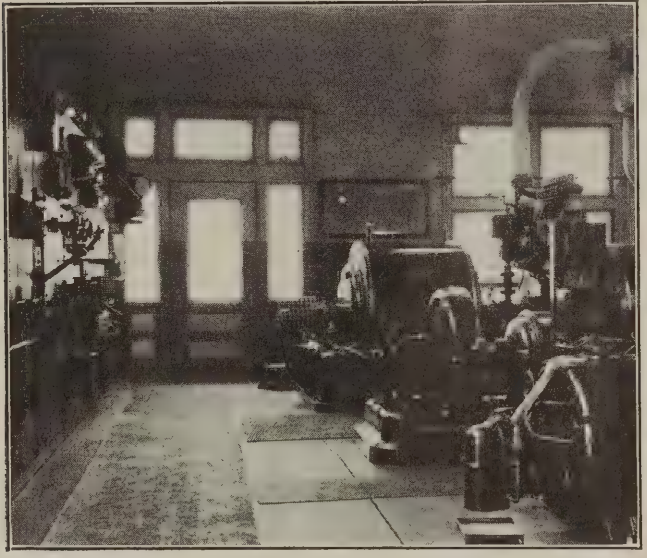
$2,000 for the ash equipment, but a check up of the first six months of its operation showed a clear saving of $9,935 over the old method of hand firing, which was that previously used. The consumption of coal per month averages about 4,882,000 lb., which includes the quantity used for the shop heating and power, boiler washing plant, engine washing, and roundhouse blower system and steam hammers in two smith shops.

Power House Equipment

The supply of compressed air is furnished by two steam driven and two motor driven compressors and the total amount of air consumed per month amounts to 102,865,968 cu. ft. This supply is used throughout all of the yards and shops, a large car repair shop being supplied from this source.

For such equipment as requires it, a direct current circuit of 250 volts is fed from a motor driven 250 kw. generator. A large steel cooling tower serves the plant for coaling turbine condensation from Westinghouse Le Blanc jet condensers.

At the present time, the purchased power is stepped



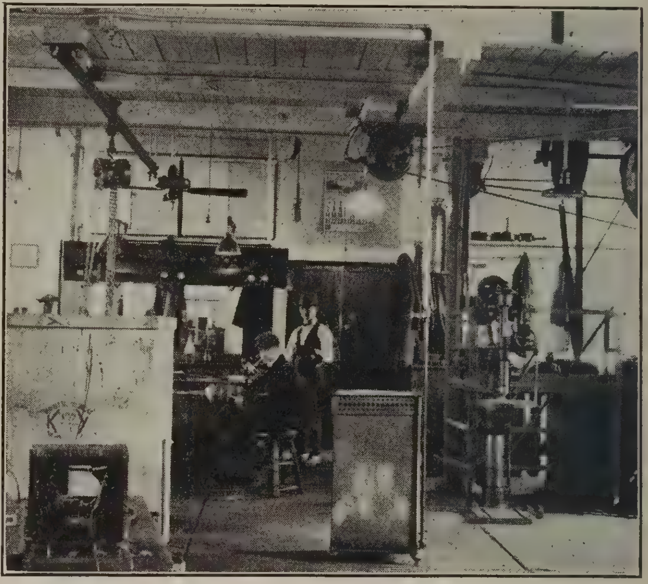
View in the Generating Part of the Power House

down to shop voltages from three 500 kva. transformers, but three 1,500 kva. transformers are on hand to be installed for this purpose in the near future. The transformers now in service are of the Westinghouse type protected by General Electric oxide film lightning arresters.

The average expense at which the power plant is operated is $8,793 per month. This amount includes coal and water, oil and grease for lubrication, waste, renewals, repairs to engines, boilers and other equipment in general as well as labor. Although these figures have been rather carefully compiled, it has been done without the aid of testing instruments. Using them as a basis, however, it shows that the cost of generated power without overhead, interest, depreciation or taxes and insurance, is approximately 9½ mills per kw. hr. For purchased power, clear of everything, the cost is 13 mills. The total power plant labor force for three shifts of 8 hrs. each at present consists of 17 men, including engineers, firemen and general maintenance men.

Other Electrical Work

In addition to the electrical men employed in connection with the power plant, another group of electricians overhaul and otherwise put in first class condition the electrical equipment on about 30 locomotives per month. Pyle



View of Armature Winding Room and Electric Repair Shop

National K-2 500-watt generators are mostly used, except on engines having train control which use M. 0.6 800-watt generators. Approximately the same amount of rolling stock is also taken care of in the same way, including passenger, mail and baggage cars. Between 115 and 120 coaches come into the yard each month for

Where Rivets Are Burned Out of Old Side Sheets of Cars—On the Elevated Platform Between Cars Ballast Resistance Grids Are Mounted in Rows

attention. Records of car lighting maintenance show the cost per car per month to be 62 cents.

The electrical repair shop takes care of all armature and coil winding work, not only in the Huntington shops, but also that which is sent in from any point between Hinton and Chicago. An average of 30 armatures of

all classes and types, as well as field coils are rewound in this shop each month.

There are 32 electricians including first-class crane operators that do electrical work on their cranes. These men with the assistance of 12 helpers and 8 apprentices do all of the work previously mentioned and look after electrical repairs that may be needed in the Chesapeake & Ohio hospital and passenger station at Huntington.

The electrical shop is equipped with a test board on the work bench at which is available for testing purposes any shop voltage used. Those commonly used are 110, 220 and 440 volts. A chain hoist is used in the shop for lifting heavy parts. This is run on a single track rail.

There are 16 Elwell-Parker electric trucks in use about the shop. Twelve of these are of the load carrying type and four of the crane type. To charge the batteries of these trucks as well as coach batteries, a 55 kw. generator has been installed with 14 circuits running to different parts of the yard. Two electricians are assigned to the duty of maintaining these trucks, one on each of two tricks, while a third man who takes care of the running repairs, works on the trucks and on the coaches as well.

An unusual and interesting line of work being carried on at the Huntington shops is that of dismantling old steel cars. The process used in removing the side sheets from these cars is the electric arc. Five or six cutters drawing approximately 500 amp. at 75 volts each from a 3,000 amp. 75 volt motor generator set. About 20,000 rivets are burned out each day at a cost of about 1.8 cents per rivet, burned off and backed out. There are two tracks in the yard which are equipped to do this work. After the rivets have been burned down and the side sheets taken off the cars are removed to the repair track where the process of reconstruction is commenced.

Pennsylvania Orders Electrical Equipment

The Pennsylvania Railroad recently announced that electrical equipment for a total of 128 passenger cars has been ordered in preparation for electric operation of the Southern division main line between Philadelphia and Wilmington, Del., and the Octoraro branch between Philadelphia and West Chester, Pa. Extensive progress is being made on the work of electrifying these lines and the new equipment for them is expected to be delivered by November, 1927.

The orders for this equipment have been placed as follows: Westinghouse Electric & Manufacturing Company, apparatus for ninety-three cars; General Electric Company, apparatus for thirty cars; Brown Boveri Electric Corporation, apparatus for five cars.

The Pennsylvania Railroad has also contracted for the electric equipment to be used in the construction of eight new locomotives to be operated in the New York tunnel service between Pennsylvania Station, New York City, and Manhattan Transfer. Four units of this equipment have been ordered from the Westinghouse Electric & Manufacturing Company and four from the General Electric Company. Delivery is expected to be completed by September, 1927.

The cars for the Philadelphia-Wilmington and Philadelphia-West Chester service will all be of the "multiple unit" type, each car carrying its own motors. In that way the power available will be automatically increased or decreased in proportion to the number of cars in the train.

The electrification work between Philadelphia and Wilmington and Philadelphia and West Chester constitutes one of the most important projects of its kind undertaken in recent years. It involves approximately fifty-two miles of line and one hundred and fifty miles of track. Its consummation will give the Pennsylvania Railroad a total of ninety miles of line and two hundred and sixty-four miles of track electrified for suburban service, directly in and out of Philadelphia. In addition, the Camden-Atlantic City electric line provides Philadelphia with an extensive suburban service via the Delaware River ferries.

The electrification projects to Wilmington and West Chester are an integral part of the Pennsylvania Railroad's plans for its new main Philadelphia passenger station on the west bank of the Schuylkill River, and the extension of electric suburban service into a centrally located underground terminal near the site of the present Broad Street Station.

A Ticket Office Without a Counter

Office of M. M. Hubbert, General Eastern Passenger Agent of the Great Northern, 595 Fifth Avenue, New York City

Illinois Central Freight Yards with Chicago Skyline in Background.—Photo by Ewing Galloway, N. Y.

Railway Electrical Men Meet in Chicago*

Seventeenth Annual Convention of the A. R. E. E. Draws Large Attendance —Number of Exhibitors Sets New Record

THE seventeenth annual convention of the Association of Railway Electrical Engineers which was held at the Hotel Sherman in Chicago from October 26 to 29, inclusive, was undoubtedly the most successful convention that the association has ever held. All of the meetings were largely attended and the discussion was both interesting and instructive. The Railway Electrical Supply Manufacturers' Association which held its exhibit as usual in connection with the convention, occupied greater space than ever before, there being a total of 60 supply companies represented.

The first session of the convention was called to order at 10:30 a. m., October 26, by President E. Wanamaker, who addressed the meeting in part as follows:

"Within a comparatively short space of time, the use of electrical equipment has grown so rapidly it has already expanded to the point where electrical equipment is used in practically every department, every phase and every angle of the railroad industry. It is the key to successful operation in the handling of trains, in the handling of locomotives, in operating the shops, in handling the water, in handling the locomotive fuel, as well as to light the engines and light the trains and light the buildings, even to its latest introduction into the field of automatic train control.

"Not only have the railway electrical men themselves striven to build up this organization and improve it from day to day and from year to year, but also the manufacturers of railway supplies and railway equipment have done so likewise, and I feel that the alliance between the railway supply men and the railway electrical men is as close as that of two brothers.

"I can think of many things I would like to say, but I do not think this is the time nor the place to say them because we did not come here to listen to somebody talk except in discussion. These discussions are tremendously valuable. Speak freely and air your opinions. Give the other fellow a chance to see how you are doing things. It will result in a lot of good.

"I am going to leave it with you, gentlemen, and I certainly hope you all have a very beneficial and profitable meeting and good time as well."

Following the president's opening address the report of the secretary-treasurer, J. A. Andreucetti, was presented, in which the growth of the association both as regards membership and finances were clearly set forth. The present membership of the association consists of 444 active members and 164 associate members while the cash on hand amounts to $5,197.69 with no indebtedness.

In the election of officers which followed, Charles R. Sugg, electrical engineer, Atlantic Coast Lines, was elected president; E. Marshall, electrical engineer, Great Northern, first vice-president, and J. C. Minick, assistant engineer, Pennsylvania System, second vice-president. V. R. Hasty and G. T. Johnson were elected to the executive committee and a nominating committee consisting of E. Wanamaker, Ernest Lunn, J. R. Sloan, G. W. Bebout and J. E. Gardner was also chosen.

*In the following pages are given abstracts of the discussion which took place on the convention floor.

Wires and Cables

This report was presented by Francis J. White of the Okonite Company. Mr. White told in brief of the activities of the numerous sub-committees of which the main committee is composed, and for the most part was concerned the adoption or rejection of certain tentative specifications.

The President: "Mr. White, may I ask what progress has been made in parkway cables?"

Mr. White: "There is no committee handling parkway cables specifically. One of the sub-committees is supposed to hand in a report on thicknesses of lead, sizes of steel cable, sizes of wire armor and such other related matters."

The President: "Recently on a new train control insulation on a new division we found that we had used some lead covered wire running from a ramp to a signal and the gophers seemed to be eating the lead."

Mr. White: "Well, of course, Mr. Chairman, any specification brought in cannot relieve the engineer in charge of the work of using his own judgment as to which particular combination of cables or protective covering should be used."

J. J. Hack (So. Pac.): "I would like to ask Mr. White if the steel sheathing on the parkway cable is of a character that will not rust away."

Mr. White: "Of course, you can always put on any type of armor than you want. Speaking for ourselves we can put on steel wrought iron or brass, but in the majority of cases the heavy steel cable appears to give the best results. We have had steel cables in railroad service now for about fourteen or fifteen years. I have had occasion to have some of them exposed and when exposed there was no sign of deterioration."

The President: "Is there any further question? If not a motion will be in order to accept the report of the committee as information and progress." Report accepted.

Radio in Railway Service

Ernest Lunn, electrical engineer of the Pullman Company, read the report. The discussion was opened by P. S. Westcott of the Pyle National Company who spoke as follows:

"On the New York Central some time ago, radio experiments were carried on in connection with the work of the Radio Committee of the Telephone and Telegraph Section of the American Railway Association. When it is realized that three tubes were used in transmission and four in reception you can see that quite a bit of power consumption was involved. If this were applied to a locomotive, for example, this would require a full output of our present headlight machine, around four or five hundred watts for radio alone. Many times worse is the situation when you go back to the caboose.

"It is possible with a single tube to communicate from the rear of the train to the front of the longest freight train now operating with relative ease, with only a fraction of the power utilized in the case of those tests that have so far been completed.

"If this sort of thing is to be put across it is first up to the railroad man to show that it is needed and secondly to show that it is needed so badly that the manufacturer will want to make it."

George W. Bebout (C. & O.): "On our long trains the engine will be so far away from the caboose and there will be so many curves, probably a few tunnels between, it is almost impossible for signals to be communicated between the caboose and the engine. We have been interested in some form of communication. We have taken it up with the larger corporations manufacturing radio equipment and they all advised us that there is nothing to date that they can offer the railroads for satisfactory service."

Roy Liston (Santa Fe): "In connection with this discussion about the communication between the locomotive and the caboose, I would just like to emphasize the importance of developing the radio along this line. I am not inclined to agree with the gentleman who just spoke about the cost of power. I think the railroads will be ready to maintain and pay the original cost of installation of anything that would meet the requirements."

The President: "Speaking from a transportation standpoint, the growth of train lengths of from eighty to one hundred twenty-five cars, with the cars running forty feet or more over all, your caboose is about a mile from you engine. This subject, therefore, is of vital importance.

"It looks to me like it ought to be possible by a little co-operation and co-ordination to develop equipments that we can use on these long freight trains."

Mr. Liston: "From what I can gather on our road, the thing we want is a means of communication both ways. We want the transmitter and the receiving sets on both the locomotive and the way car. This seems to have tremendous possibilities, not only with that communication alone but a further development in train dispatching methods."

The Secretary: "Mr. Chairman, I think that the committee from now on should devote more attention to the subject of communication between the cab and the caboose or communication on the train rather than to the pleasure end of the radio proposition on cars. As I see it the Radio Committee has wonderful possibilities of doing a real constructive job for the railroads."

The President: "I think we have practically agreed among ourselves that we have at least developed an outline to guide the committee in their work for the coming year."

The report was accepted and the committee continued.

WEDNESDAY SESSION

Train Lighting

P. J. Callahan, supervisor of car and locomotive electric lighting on the Boston & Maine presented the report on train lighting. The discussion was opened by A. E. Voigt, car lighting engineer of the Santa Fe, who spoke as follows:

"I do not object to these clearances, but I am doubtful if you can always obtain these clearances. I do not consider the clearance over the end sill of sufficient importance to insist on an inch and a quarter, especially on a truck hung machine, inasmuch as the clamps are on the outside of the belt.

George R. Shirk (C. G. W.): "The minimum inch and a half between the axle pulley and the girder is altogether too close. The minimum over an axle pulley on all girder type cars should be not less than three inches."

Mr. Hack: "I thoroughly agree with Mr. Shirk on that. Anything less than three inches will strike when you get a low spot in your track."

Mr. Townsend (Santa Fe): "I agree with Mr. Shirk. I had a case yesterday of a Pullman car with an eighteen inch axle pulley and a clearance of two and three-quarter inches and yet the bolts on the girder were striking the belt right down through the center."

Mr. Lunn: "Mr. Chairman, it looks as if it was a matter of the diameter of the axle pulley more than anything else. It is rather difficult to change the design of cars sometimes and if we want more than three inch clearance we have simply got to change the diameter on the pulley."

Mr. Bouche (Gould Company): "I would like to see a three inch clearance of the axle pulley flange at any and all times, but I absolutely know that it is not possible unless you want to make the diameter of the pulley so small that you will have slipping in the winter weather, which is a thing we have to avoid."

L. S. Billau (B. & O.): "I think that we should attempt to establish minimums that represent the best possible compromise and then leave to the individual railroads the question of getting the maximum clearance that they can on the particular cars they are handling."

The President: "In view of the statement made by Mr. Billau I think it would be a good idea to take a vote on the recommendations as they have now been made by the committee and members here this morning. If there is no further question a motion is in order to approve this recommendation."

A. E. Ganzert (Rock Island): "I move that we approve the amended recommendation."

J. R. Sloan (P. R. R.): "I second the motion."

Motion carried.

Mr. Shirk: "I would like now to pass the belt clearance on to the recommended practice of this Association, that all belt clearances will be over the end sill and under the brakebeam, that in all future construction where the truss rod type of beam is made that the bridle arrangement will be so made that a flat brake beam offset upward of two and one-half inches can be used and all the belt passages will be under the brake beam. It is feasible and I think it should be the recommendation of this Association to car builders that all future cars of that type should have this arrangement where axle devices are used."

Mr. A. E. Voigt (Santa Fe): "I am favorable to all the clearance that it's possible to get, but I hardly think this Association is in a position to say just how a brake beam should be constructed."

The Secretary: "We certainly do not want to make any recommendations that are out of line. I am not saying this particular recommendation is out of line, but we want to give recommendations of this kind very serious thought."

The President: "Mr. Callahan has said, as Chairman of the committee, that in view of the importance of this problem that it be referred back to the committee and said they be given the opportunity to give it further consideration."

Mr. Voigt: "I move that the question of whether the belt shall be over the end sill or under the brake beam be referred back to the committee for the coming year for further consideration."

Mr. Sloan: "I second the motion." Motion carried.

Mr. Ganzert: "I would recommend that the axle pulleys shall be mounted on the center line of the car. I want the equipment builder to get the body hung machine on the center line of the car."

Mr. Callahan: "Why wouldn't it be well to word it this way that the axle pulley shall be mounted in the center line of the car? That will take care of the whole thing, won't it?"

Mr. Ganzert: "No, sir, it will not. We want the armature pulley mounted on body suspended machines so that the armature pulley will be on the center line of the car."

Mr. Billau: "I want to call attention to the fact that there is available today the so-called interchangeable axle generator suspension which manufacturers of axle lighting equipment are all in a position to offer. I believe it would be desirable for the committee next year to go further into this with the view to the Association establishing a recommended standard mounting for axle generators of the body hung type."

Mr. Voigt: "I would like to have seen that discussion of voltages entered into on train lighting as to the desirable voltage. Personally I think that Mr. Callahan's suggestion in the report, that we try to hold to 32 volts is good."

The Secretary: "This refers, I believe, to suburban car lighting. I believe it is a mistake to go to 32 volts for suburban car lighting when you consider lighting eight or ten cars."

Mr. Callahan: "Mr. Chairman, as regards that I feel that the additional installation cost is more than overbalanced by the cheaper maintenance cost. If it becomes necessary to use batteries you are permitted to use a 32-volt battery."

The Secretary: "I do not agree with the chairman of the committee in that respect. My experience has been entirely different. I have found that the 32 volt system is more troublesome."

Mr. Wescott: "So there will not be an erroneous opinion on what is possible, it is very true that there are cases where 32 volt for the lighting in the car is desirable but with interchange there comes another possibility that has been tried in the past and found perfectly satisfactory, and that is using a series parallel arrangement of lamps. It is possible to use the 32 volt lamps if you care to and still have the advantage of the 64 volt train line at the same time."

The President: "I would say, Mr. Callahan, in view of the discussion here that it might be well for your committee to consider recommending that the voltage that is used on suburban train lighting be determined by local conditions after you have had a chance to get into it further."

The Secretary: "I move that the report be received as information and that the committee be continued and that such questions as came up in the discussion of this report that can be whipped into shape for recommended practice be presented at the next annual meeting." Motion carried.

Electric Welding and Heating

F. H. Williams, test engineer for the Canadian National, presented the report on Electric Welding and Heating, and the material which the committee desired to add to the manual was placed on the secretary's desk for examination by the members. Mr. Spangler of the Westinghouse Electric & Manufacturing Company, who was called upon to discuss recent developments, spoke in part as follows:

"During the past several years we have conducted a number of tests on welding structural steel members, and these tests showed principally that this type of work could be done very probably with great economy as compared with the standard riveted steel members.

"We have put up two small buildings in East Pittsburgh by the welding method and at the present time there is a five story building being constructed for the Westinghouse Company at our Sharon, Pennsylvania, plant by the American Bridge Company, and in this building all of the shop work and all of the field work is being done by the electric welding method."

The President: "The growth of the use of electric arc welding has simply been astounding within the last eighteen months. Architects and the engineers and the greatest of them in this country, are paying more attention to the development of welded structures than they are to any other type of design.

"Today the architects and the engineers are leaning very largely on the electrical manufacturers to aid them in developing this process.

"We recently took thirty-two of our original electric welders and traded them in on new modern machines, because in the comparatively few years the improvements have been so great as to make the original welding equipment practically obsolete today. The machines that we now are installing will cut our welding cost operations in half."

Mr. Lunn: "Within the last six months the question of chromium plating has come up. We cannot afford to, shut our eyes to this subject and I recommend that the committee be instructed to consider that as a part of their work next year."

Mr. Williams: "I would like also to suggest that they be authorized to go into the subject of acetylene welding so that we can place before the electrical engineers the results that can be obtained by acetylene welding, and thus show that the electric welding can be used in probably more places than it is at present and more economically than acetylene welding."

Mr. Sloan: "Mr. Chairman, I would move that the recommendation of the committee be accepted."

Mr. Gilman: "I second the motion." Motion carried.

THURSDAY SESSION

Safe Installation and Maintenance of Electrical Equipment

George T. Johnson, assistant electrical engineer for the New York, New Haven & Hartford, presented the report. Mr. Johnson introduced the subject as follows:

"The assignment to the committee this year was unlimited. I would suggest for the next year's committee that the assignment be limited and that they make a shorter report because even though we do not read it here a great many men cannot take the time to go over this report."

The Secretary: "Is there any point on the question Mr. Johnson raised of the voltages from 601-5,000 against 750-7,500?"

Mr. Johnson: "It is simply whether you want to follow the electric code or follow the safety code."

The Secretary: "As I understand it, the electric code is 601-5,000 and the safety code is 750-7,500. That is the question. Is there any discussion on that?"

The President: "What code do you recommend as Chairman of the committee?"

Mr. Johnson: "My own personal opinion is that perhaps we would better get the safety code because the engineering societies are going to that."

The President: "Well, since there is no discussion we will put it to a vote."

The Secretary: "Mr. Chairman, I move that we change the paragraph to read 750-7,500 volts."

Mr. Sloan: "I second it." Motion carried.

The President: "Is there any discussion on the subject of grounding?"

Mr. White: "The first paragraph under grounding recommends that the sizes of the National Electric Safety Code be discarded and the proper size of wire be worked out allowing a safety factor of three. I think it might do us all some good if the committee would enlighten us on that point as to why that paragraph is in there."

Mr. Johnson: "The code says, 'More than 500, but not more than 600 amperes.' Switches are built at the present time up to 1,200 amperes, you are liable to build them larger, that is, with fuses in multiple. If you will note especially with copper wire under size of wire No. 2 the fusing current is 1,342 amperes. Now you have not got much leeway in case of a short circuit underground. The factor of three is just simply something that has come out of our own minds. Whether it is three or two or four or five, that is a matter for the Association to judge."

There is something further I would like to say on battery charging. We have tried to stress this modified potential charging. It is not used in car lighting on account of the various different types of batteries, but on this tractor system, in order to save labor, we have found it to be of great advantage."

Mr. Sloan: "Mr. Chairman, under the head of Water Supply I would move that that be amended to read, 'It is essential that in all battery rooms a supply of distilled water be available.'"

Mr. Johnson: "It is a question. Sometimes the battery companies permit us to use other than distilled water. Would you put a still in under those conditions?"

W. L. Bliss (U. S. L. Co.): "I might say a word on that subject of water. We are battery manufacturers and in the initial filling of batteries at our plant we use the Niagara River water and we advise our customers to use distilled water."

Mr. Sloan: "Mr. Chairman, in our part of the country there is a very large percentage of iron in the water and we would ruin the batteries in a very short time if we used the ordinary water supply."

Mr. Marshall: "Mr. Chairman, I would like to say that it has been our practice in taking care of batteries on the Pacific Coast to use the hydrant water because it is a well known fact that the water that we have there is very pure."

Mr. Sloan: "I will change my motion to read like this, that it is essential in all battery rooms to have a supply of distilled water to fill up the cells from time to time, replacing water which has evaporated, unless chemical analysis of the natural supply proves it to be suitable."

The Secretary: "I second the motion." Motion carried.

The Secretary: "There is a good deal of material in Mr. Johnson's report that would make good data for

the manual, and I make a motion that the report be received and turned over to the Committee on Manual to peruse and take out of it such matter as would be of benefit in a constructive way to railway men in guiding them in safe installation and maintenance.

Mr. Sloan: "I second the motion." Motion carried.

Illumination

The report was presented by Mr. Billau, who moved the adoption of a number of recommendations the first of which is as follows:

"It is recommended that the train lighting lamps as listed in Table 4 be substituted for the lamps now listed in Table 4, of Section V of the Electric Train Lighting Section of the Manual, with the understanding that these new lamps will gradually supersede the present type."

Mr. Callahan: "I second the motion." Motion carried.

Mr. Billau: "Substitute for Paragraph 1 of the manual, the section covering locomotive headlights which covers G-30 bulb, the following:

"The 250 watt, 32 volt, P-25 bulb concentrated filament lamp is recommended as standard for use in headlights of road engines. Secondly, eliminate the present paragraph which offers that lamp as an alternate standard. I offer that as a motion."

Mr. Sloan: "I second the motion." Motion carried.

Mr. Billau: "I submit as a motion the following change in the Manual: 'The 15 watt, 33 volt, S-14 bulb locomotive cab lamp is recommended as standard for use in cabs, signals, engine number lights and all other outlets than the headlight lamps, and secondly, to eliminate the paragraph offering that lamp as an alternate.'"

Mr. Callahan: "I second the motion."

The President: "Is there any discussion?"

Mr. Hack: "I would like to ask Mr. Billau or the lamp manufacturers if the S-14 cab lamp has proved satisfactory in lamp life. I have heard indirectly that it has not."

Mr. Billau: "I can only report as far as the experience on the Baltimore & Ohio is concerned. Our road changed over several months ago and while we have not yet been using the new lamp generally, in other words, while there is still a mixed stock of lamps on the railroad, the bulk of them in use today are the new lamps and our performance indicates that we are getting better results with the new lamps than with the old."

Mr. Hack: "Have you kept tests of the life of lamp hours in actual service on the locomotive, not on laboratory tests?"

Mr. Billau: "Our records are based on the actual record of lamps issued. There are representatives from the manufacturers here. They may have something to say on the subject."

A. L. Broe (Edison Lamp Works): "All I can say is that all the reports that we have had on the S-14 cab light have been favorable. I have not heard of any unfavorable service."

Mr. Ganzert: "We have several hundred lamps and we have found the service life did not compare favorably with the S-17."

Mr. Bebout: "We did not get a chance to find out about the life. When we put them in the cabs the engineers complained seriously and we had to take them out. They did not like them. They said they did not get enough illumination."

Mr. Johnson: "Mr. President, not in the cab range but in the marker lamps we found some complaint, but it was due to the mounting."

J. L. Minick (P. R. R.): "Mr. Chairman, our road is not using the S-14 bulb lamp at the present time due largely to the fact that to mount it properly in a number of fittings it will be necessary to revise the fittings. I have reference particularly to the classification and marker lights. The difference in the light center is sufficient that our road would want to raise the sockets."

Mr. Billau: "As the matter stands now, we have a motion before the house to be voted upon but the discussion has brought out that there seems to be differences in experience and if it is deemed unwise to place this lamp as a recommended lamp for cab light service, as far as the committee is concerned, we would be very agreeable to letting it stand as it is under our recommendations today as an alternate standard."

The President: "Do you withdraw the motion?"

Mr. Billau: "I will withdraw it. I might add that on the Baltimore & Ohio we have substituted the new lamp without so far making any changes in the cab fittings or our classification lights."

Self-Propelled Vehicles

This report was presented by R. G. Gage, electrical engineer, Canadian National. In discussing the report Mr. Gage opened the discussion as follows:

"I would like to say, Mr. Chairman, that when this work was undertaken there was no instruction book covering the Electric Motive car that suitably filled the operating requirements, and this was also true as far as we know at the time with the Brill Westinghouse car. Since this time, however, the Brill Company have issued a very complete book of instructions on their gasoline electric car following very generally the lines that were followed in the one that we have submitted.

Mr. Bebout: "Mr. Chairman, I would like to ask that the manufacturers, when they produce this instruction book, either furnish a piece part catalog or devote a few pages to showing the number and the name of the parts that need replacing.

"I would also suggest that those instruction books be mede up in some standard size to show that we can put them in our folder or catalog case."

Mr. Lunn: "Mr. Chairman, it occurs to me that in the publication of an instruction book of that size, the committee could work with the manufacturers and get them to agree to submit their proofs to the committee and get the committee's approval before making the publication."

Mr. Sloan: "I would move that any manufacturer of self-propelled rail cars be requested to submit instructions in as much detail as may be considered necessary to the Association of Railway Electrical Engineers for their approval of the practices and standards recommended, and that those instructions be submitted to our committee on that subject, and that when those instructions are approved by that committee that then the manufacturer shall have the privilege of printing them and showing on same that the instructions have received the approval of the Association of Railway Electrical Engineers."

Mr. Johnson: "I second the motion." Motion carried.

FRIDAY SESSION

Train Control

F. E. Starkweather, electrical engineer of the Pere Marquette, read the report on train control. The discussion was begun by Mr. Wanamaker, who spoke as follows:

"Gentlemen, you have heard the request of the Chairman of the committee for some discussion on the particular item, what effect has train line leakage with Train Control applications. We would like to hear from some of you."

Mr. Liston: "Mr. Chairman, the train line leakage is a prime factor in the automatic reduction in that it affects the reduction materially, not that it in any way affects it detrimentally but train line leakage tends to apply the brakes throughout the train usually in a more uniform manner than can be accomplished with the automatic brake valve.

"Our standard practice, or I believe standard practice on most railroads, is five pounds leakage per minute, but on long freight trains this is often exceeded especially after the trains are out on the road for a few hours."

The President: "Mr. Rutledge, we would like to hear from you."

Mr. Rutledge: "I do not know that I have anything to say."

The President: "Suppose that all the signals are clear, and the train running along has just passed a clear board. He has no more than got by that signal with a clear board until an accident happened, we will say, in the next block throwing the signal ahead of him to red. Let us suppose one thing further on that, that due to low visability, stormy weather or something, and the fact that the engineman was incapacitated at this particular time so that he is not able to handle his train in accordance with this red board, what has been done to insure that when the engine receives that red board indication the application by automatic train control will be such that there is practically no danger of buckling or breaking the train in two?"

Mr. Rutledge: "In our case we get a constant slowdown which would cause him to stop in approximately 3,500 feet at 75 miles an hour. As far as the reductions are concerned, we have had some brake applications on trains at sixty miles per hour and the locomotive on this train came to a dead standstill twelve seconds before the train line pressure in the caboose had begun to reduce, and we did not have a pile up, while everything was favorable in that direction."

The President: "What is the operation of that device to hold a reduction in train line pressure so that you do have, we will say, a maximum length of 3,500 feet, and that you do not pile up the train?"

Mr. Rutledge: "By the use of a certain size orifice which restricts the leakage of air from the train line which sets the brakes."

The President: "You have had one train, but have you had more than one that you know of?"

Mr. Rutledge: "We have had a lot of brake applications at different speeds and to my knowledge we have never encountered any serious difficulty."

Mr. George B. Colegrove: (I. C.): "We have just equipped fifty engines at the Lima plant, with equipment operating with super-heated steam; that is, everything on the engine is operated with super-heated steam. The principal problem that we have to meet is the matter of lubrication headlight equipment.

Mr. Kennedy: (Pyle National Co.) "Mr. President, the use of super-heated steam in the turbo generator is something that is comparatively new. So far we have experienced some valve trouble. That is due to either one or two conditions, either that the foreign matter in the steam, in the super-heat, comes out as solid matter causing small particles to get along the walls of the valve causing sticking and the other, that the high temperature of the steam leaving the valve first causes the valve to expand against the walls of the turbine casing.

"We are going into it very carefully now and perhaps a little later on we may be able to give you more valve data."

The President: "If there is no further discussion, it is in order to entertain a motion that the report of the committee be accepted."

The Secretary: "Mr. Chairman, I move that the committee's report be accepted as information and the committee continued."

Mr. Ganzert: "I second the motion." Motion carried.

Locomotive Lighting

The report on Locomotive Lighting was read by L. C. Muelheim, chief headlight supervisor of the Baltimore & Ohio. The discussion began with Mr. Colegroves remarks as follows:

"Our road has adopted a cast aluminum headlight case, and when we changed over from the old style sheet metal case eighteen inch reflector to the smaller case and mounted these headlights on our present brackets, it looked all out of proportion. When at Schenectady about two years ago, I noticed a mounting of the Boston & Maine where they mounted the headlight case directly on the smoke box door. It made a very neat installation. It has several advantages over the shelf mounting. This mounting we have adopted as a mechanical standard. Our mechanical engineer designed a bracket for it that is riveted right on the smokebox door and the lamp is bolted onto that and it is a perfectly level setting. The light is in the proper position and there is no reason why the lamp after once being focused should be changed."

Mr. Byrne: (N. Y. C.) "On this headlight case proposition we have got another point to consider. We are operating fast trains that cross numerous highways where dense automobile traffic is crossing. The average automobile driver looks up and down the track, his engine is making a noise, and he looks for the light. I recommend that this headlight case proposition be given consideration from the standpoint of an auxiliary light."

Mr. Ganzert: "I would like to know whether the other roads are having the same trouble with headlight lamps that we do. I have talked to quite a few individuals and it seems they all have the same trouble but nobody gets up and talks about it. The trouble seems to be in the failure at the connection between the lead-in wire and the filament. We get lamps, maybe a thousand at a time, and we will find that there will be several hundred of them that fail within the first several hours or in some cases we have failures before they are put into the service at all."

Mr. Billau: "The work of our Committee on Illumination has brought us in rather close touch with the

lamp manufacturers and I have had the matter brought to me time and time again that many of the complaints brought out before the Association on the floor, the lamp manufacturers have never heard of or they have never heard of them in such a way that they could take very much action. I feel that it would be a help to all of us where we find trouble of a chronic character with lamps that each individual road take action to bring the matter forcibly before the lamp manufacturers. I think they will appreciate this."

THE PRESIDENT: "I have been bothered by headlight lamps for a long while. I do not know how they do on the majority of roads; I think on our road they run them until they burn out.

MR. SLOAN: "Mr. Chairman, we make it a practice of operating our passenger equipment by putting in a new lamp at the boiler washing period, putting the old lamp in freight service. That has cut down our failures very materially."

MR. COLEGROVE: "We change our passenger equipment every thirty days and put the lamps in the freight service. That has materially reduced our trouble from lamps in passenger trains."

MR. SLOAN: "I move the report of the committee be accepted and the committee continued."

THE SECRETARY: "I second the motion." Motion carried.

Loose Leaf Manual

The final report of the convention was presented by Mr. Billau who spoke on the subject of the Loose Leaf Manual as follows:

"The points brought out in the report are largely matters that indicate the line of procedure that it seems desirable to carry out in the future to help build up the Manual to the form we would all like to see it. I have felt personally, and I think all of us realize that the Manual of the Association is the measure of its production work. It is our duty to make our Manual so valuable that every member of the Association will keep his copy where he will have occasion to refer to it frequently. If we do not have that kind of material in the Manual it is hoped that our committees in the future will cover the character of work that will make it valuable."

MR. SLOAN: "Mr. Chairman, I move that the action as taken by the committee be made and the committee continued."

THE SECRETARY: "I second the motion." Motion carried.

The seventeenth annual convention then adjourned.

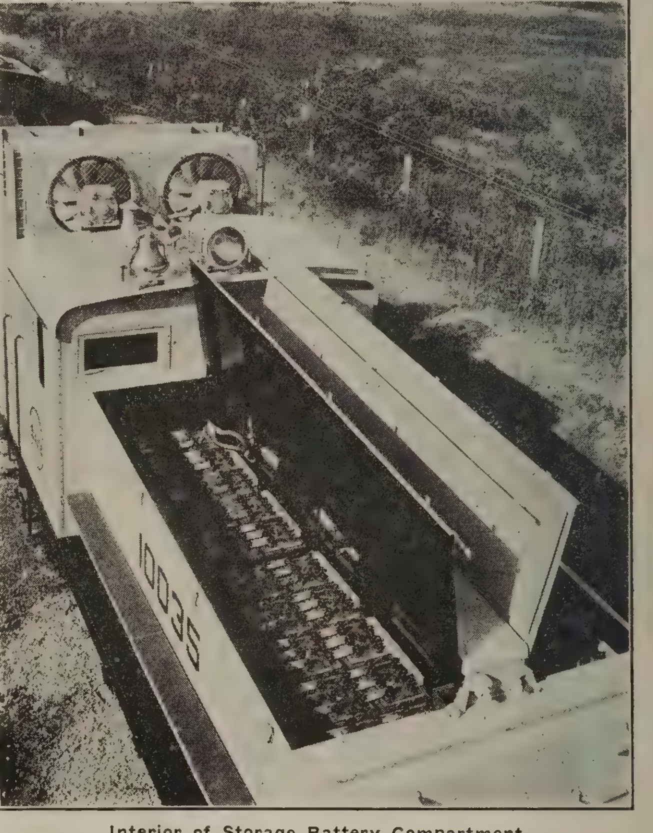
Supply Men Elect Officers

At the election of the Railway Electrical Supply Manufacturers Association the following officers were chosen: President, W. H. Fenley, Kerite Insulated Wire & Cable Company; senior vice-president, George R. Berger, Gould Storage Battery Company; junior vice-president, Wm. A. Ross, Pyle National Company; secretary-treasurer, Edward Wray, Purchases and Stores. The new members of the executive committee are Russell Murphy, Square D Company; H. C. Gump, Graybar Electric Company; and H. A. Morrison, Simmons-Boardman Publishing Company.

The exhibit of the supply men on display during the convention occupied considerably more space than usual, a total of 60 manufacturers being represented.

Combined Storage Battery and Gas-Electric Locomotive

THE Chicago & North Western is now suing a storage battery locomotive weighing 110 tons and capable of hauling a 1,500-ton train, equivalent to 70 empty or 30 loaded freight cars, at a speed of from eight to 10 miles an hour. This unit has many of the advantages of the usual electric locomotive without requiring an overhead trolley or third rail for its source of power. It will be used for some time in the freight yards of the Chicago & North Western to demonstrate its possibilities in solving some of the problems of railroad terminal electrification in that city. The locomotive, incorporating features of both the storage battery and the gas-electric drive, has a number of novel features which make it particularly adaptable to switching service.



Interior of Storage Battery Compartment

The control is so arranged that power can be taken entirely from the storage battery, or the gas-electric drive can be used. If more power is needed than is being supplied by the gas-electric unit, the storage battery supplies energy in parallel with the engine-driven set; if the gas-electric unit is supplying more power than is required by the motors, the excess automatically charges the storage battery. In switching service, the battery can thus be used to supply power, with the gas-electric unit used during slack periods to keep the battery charged. The storage battery can also be recharged by outside power.

It is intended to use the storage battery as the source of power for the traction motors under ordinary circumstances. The proportions of these batteries have been selected so that under ordinary conditions of switching operation the battery will furnish sufficient electric power to handle the locomotive for one day's

service without recharging. The entire space in the two sloping auxiliary end cabs is devoted to this battery equipment. The battery is made up of 120 cells, type FL-31, Exide Iron Clad, with a capacity of 616 kw. These storage batteries can for short periods deliver 1,000 hp. to the driving motors.

The auxiliary gas engine generating set, provided for recharging the batteries, permits the locomotive to be kept in continuous service and operated, if necessary, on tracks remote from the regular charging facilities. Under ordinary switching service in Chicago, the battery will be charged at night, or at other times when the locomotive is idle from special equipment installed by the Commonwealth Edison Company in the freight yards.

The gasoline engine set is known as the Winton model 106-A power plant. The engine is a six-cylinder, 1,000-r.p.m. unit with 7¼ in. by 8 in. cylinders. The generator, built by the General Electric Company, is a type DT-508-A shunt-wound machine designed to supply 230 volts. A radiator of the fin tube type is mounted on the roof of the central cab, and forced ventilation is provided by two motor-driven fans. A pump, driven directly by the engine, circulates the cooling water; for protecting the cooling system against freezing when the engine is idle in winter a small coal-fired heater is provided. Suitable valves and piping connections are supplied for passing the hot water through radiators located at each control station, thus providing heat for the cab during cold weather. A 150-gallon fuel tank is suspended underneath the platform. The gasoline feed to the carburetor is effected by a magnetically operated diaphragm pump.

Each of the four axles of the locomotive carries a GE-287 motor driving through a single reduction gear. The gear reduction is 66/16. The motors are of the longitudinally ventilated construction, and provision is made for forced ventilation. The control is of the PCL single-unit double-end type, providing nine resistance points, one free-running point and one reduced-field point with the motors in series parallel. With a full multiple grouping of the motors, there are seven resistance points, one free-running point, and one reduced-field point. A reversal of operation is obtained by an electro-magnet switch which reverses the motor fields.

The battery is divided into two sections, connected in series during locomotive operation and when charging from the gas engine side on the locomotive. A manually operated series-parallel switch provides connections for charging the battery from an external source with the two sections connected in parallel. Suitable interlocks insure against the possibility of improper operations. An ampere-hour meter automatically opens up the charging circuits when the battery is fully charged, and shuts down the gas engine if the charging current is being taken from the auxiliary side.

Separate watt-hour meters measure the power consumed by the locomotive, the input from the generator, and the input from any external charging circuit. Ammeters are also provided for indicating the motor and generator current. Type No. 14EL straight and automatic air brake equipment is provided, the air being furnished by a CP-26, 100 cubic foot compressor.

The locomotive is of the steeple-cab type, with two swivel motor trucks. The platform is built up of structural steel having channel side sills and I-beam center sills. The couplers carried at each end of this platform are A.R.A. friction draft gear with 5 in. by 7 in. shank. The trucks are rigid bolster, equalized type with side frames of rolled steel plate.

The cab is made up of a central section containing the two control stations, contactors, resistors, relays and other auxiliary control equipment and the gas-engine generator set and air compressor.

The table lists the principal weights, dimensions and other data for this locomotive:

The Locomotive Is Now in Switching Service in the Chicago Freight Yards of the Chicago & North Western

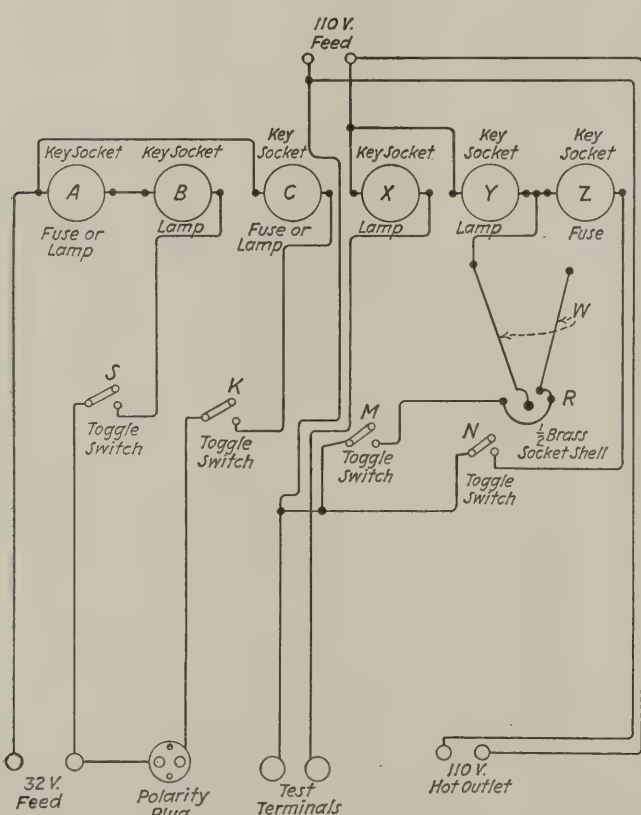
Weights	
Locomotive complete	237,000 lb.
Mechanical equipment	100,700 lb.
Battery	78,960 lb.
Motor	29,800 lb.
Engine and generator	7,850 lb.
Radiator and fan	3,500 lb.
Control	9,150 lb.
Brakes	5,640 lb
Heater	1,400 lb.
Dimensions	
Length overall	52 ft. 0 in.
Wheel base	39 ft. 0 in.
Rigid wheel base	8 ft. 0 in.
Height	14 ft. 8 in.
Width	10 ft. 0 in.
Tractive effort, one hour capacity	17,200 lb.
Speed at one hour rating	9½ m.p.h.
Tractive effort, 30 per cent coefficient of adhesion	66,000 lb.
Maximum speed	30 m.p.h.
Time motors will carry max. tractive effort	9 minutes

Electrical Test Board

By L. E. Brant, Headlight Maintainer

In order to keep headlight equipment in first-class condition at all times I have constructed a test board, a wiring diagram and photograph of which are shown below.

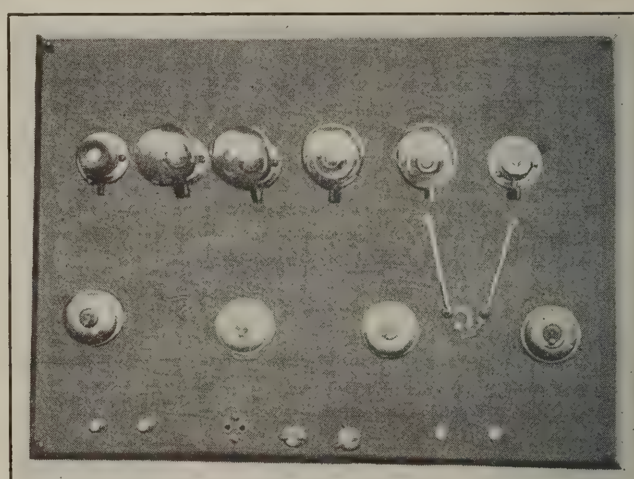
It will be noted that the board is very simply constructed, but the wiring is so arranged that any test re-



Wiring Diagram of Electrical Test Board

quired can be made. The left side of the board is for 32-volt use and the right side for 110-volt use, but by using bus wires both sides may be used for either 32 or 110 volts.

When testing a generator, the leads from the generator are connected to the lower terminals marked "32-volt feed," a 250-watt lamp is placed in each of the sockets *A* and *B* and a fuse in socket *C*. A voltmeter is then plugged in at the polarity plug receptacle and the toggle switch *K* is closed, giving a reading of the generator voltage with a full rated load. The toggle switch *S* is then opened and a reading is had with no load, showing the voltage rise from full load to no load.



Electrical Test Board Showing Location of Switches, Fuses, Terminals, Etc.

There are numerous other tests which one can make, for example, the testing of lamps for use on engines which, although 32-volt lamps, will stand as high as 60-volts momentarily. If a generator is not handy to hook on the 32-volt side, put a lamp in socket *Y* and touch the lamp to be tested in the half socket *R*. A 110-volt lamp for lighting use may be tested in the same manner with the socket *Z* turned off and the toggle switch *M* closed. Cartridge fuses are tested by placing them across the bus bars *W*.

When either lamps or fuses are tested in the half socket or cartridge fuses are tested on the bus bars a circuit is closed through the lamp *Y* which will be lighted.

It is sometimes desirable to have 110-volt terminals always hot close at hand for running motors, fans, etc., and for this purpose I have added two binding buses at the lower right-hand side marked 110-volt "hot outlet."

The polarity plug receptacle in the 32-volt circuit may be used for other things beside the voltmeter previously mentioned. For instance, I sometimes have used it for a 32-volt lamp away from the test board when the 110-volt circuit is out of use. For this purpose I have a

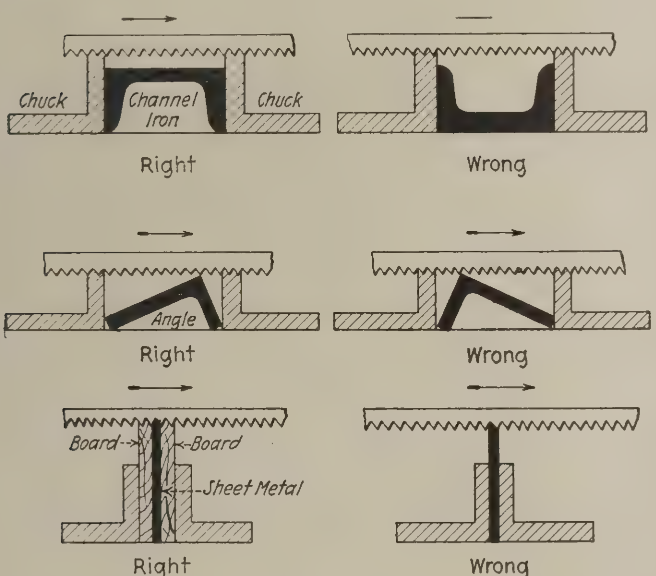
weather-proof socket with plugs soldered on for inserting in the polarity plug receptacle. For testing coils, armatures, etc., for shorts, grounds and opens, there are two terminals in the center marked "test terminals" with a lamp in series. For ordinary lighting a lamp is placed in socket Y and the toggle switch N is closed.

These are the principal uses for this test board but, no doubt, as the occasion arises I will find other uses, and should any reader have use for this kind of a test board he will probably find other uses also.

Proper Use of Hack Saw Blades

In a recent issue of the Erie Railroad Magazine, H. E. Blackburn, instructor of apprentices, has given some useful information in connection with the use of hacksaws. As electricians frequently use hacksaws as well as machinists, the following paragraphs by Mr. Blackburn can scarcely fail to be of interest to the readers of this department.

The hacksaw as used in a railroad shop is the most expensive small tool purchased, due mostly to not knowing how to use it. More saws break than wear out, if used in a hand frame, while in a power saw the same kind of blade will wear out before it breaks. It is up to



Sketches Showing How Hack Saws Should and Should Not Be Used

the man to learn how to fasten the saw in the frame and give it the proper tension. Through ignorance, a hard tempered saw may be easily twisted, bent and broken. A coarse pitch saw should never be used on thin sheet metal or pipe. Always use a fine pitch for this work. For all-around work over one-half to two inches thick, 18 teeth to the inch is a good standard, while a blade of 24 to 32 teeth to the inch is best suited for thin sheet or tubing.

However, with due regard to using the proper saw for the work in hand, the most important thing to know is the amount of pressure to apply on the blade. Too light a pressure will wear away the saw and it will do little work. A light pressure should be used only in starting the cut, while a heavy pressure is destructive at all times. Manufacturers claim that from 20 to 30 pounds is a good pressure for power saws after the cut has started, to the width of the saw—in other words, start with a light pressure until the saw has started straight, then load the pressure on; 20 to 25 pounds is good for hand sawing, but this is hard to determine.

The efficiency life of a saw lies in regulating the pressure to suit the work, so the saw will give the greatest number of cuts in the shortest time.

A good test is to place a 3-inch piece of machine steel in a power machine saw. Try a 20-pound weight. The saw should easily cut through this piece of work in 35 minutes. Try it again, using a 30-pound weight, and it should do the work in 24 minutes. A factory test for power saws is a 50-pound test, in which case the work is done in 10 minutes, but in this test the life of the saw is shortened.

The cutting speed is another important factor. With power saws using a lubricant on machine steel 60 strokes is a good average, or, say, a stroke in a second of time. If the work is hard 50 strokes is a good cutting speed for hand sawing. In power saws 65 strokes per minute, using 56 pounds pressure and plenty of lubrication, is doing good work. Dry cutting with power saws on steel is not recommended.

To mount a blade, tighten it until it gives a humming sound when "thumbed." In power work, be sure the work to be sawed is fastened so it will not move. And in cutting sheet metal, place the work in the vise so as to expose the flat parts to the teeth of the saw, rather than the thin parts (note sketch). If you have to saw thin metal, clamp a 1-inch piece of hard wood on each side of the sheet metal to be sawed.

Finally, observe the following rules: Be sure the saw is cutting, not rubbing. Always lift the saw on its return stroke, and never crowd the saw. Speed does not mean anything when above one stroke per second, and, above all, study the chart furnished by the manufacturers.

Carelessness

"A railroad crossing is dangerous only when made so by careless driving. No prudent person would run over a red light in the highway, for it is there as a warning, yet motorists frequently not only run over a crossing flagman and break down crossing gates warning them of an approaching train, but with scarcely less frequency run into a train from one to five cars back of the engine, and then ask taxpayers to tax themselves for grade changes to eliminate the danger, when the danger is not in the crossing, but in the driver."

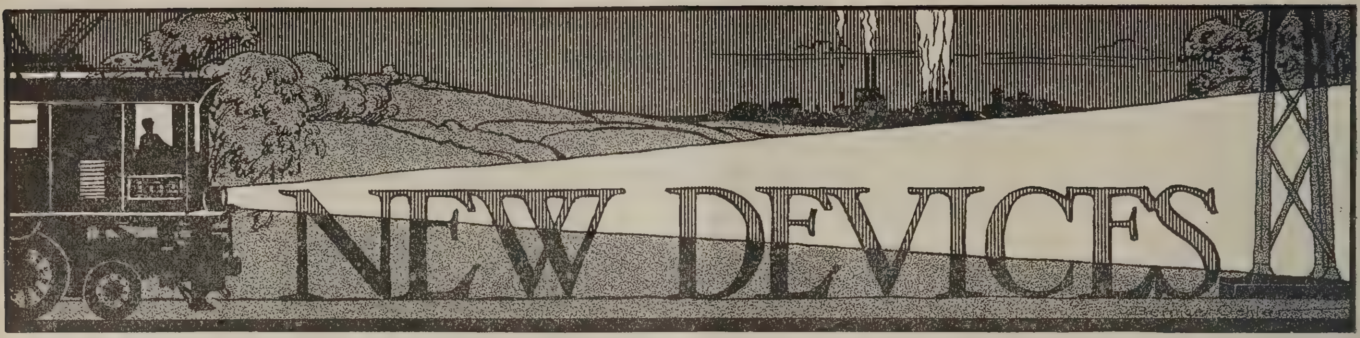
Teacher—Johnny, give me a sentence using the word "diadem."

Johnny—People who drive onto railroad crossings, without looking, diadem sight quicker than those who stop, look and listen.—L. & N. E. Magazine.

Eight—Grandpa, why is it that you have no hair on your head?

Eighty—Grass does not grow on a busy street.

Eight—Oh, I see. It can't get up through the concrete.



Thrust Bearings

A new line of thrust bearings have recently been developed by the Marlin-Rockwell Corporation, successors to the Guerney Ball Bearing Company of Jamestown, N. Y. The new bearings are known as M-R-C thrust bearings and are designed to support end thrust loads only. The bearings are made both single acting or

No. 11 B—M-R-C Thrust Bearing

double acting to compensate for hand thrust loads acting in either one or two directions.

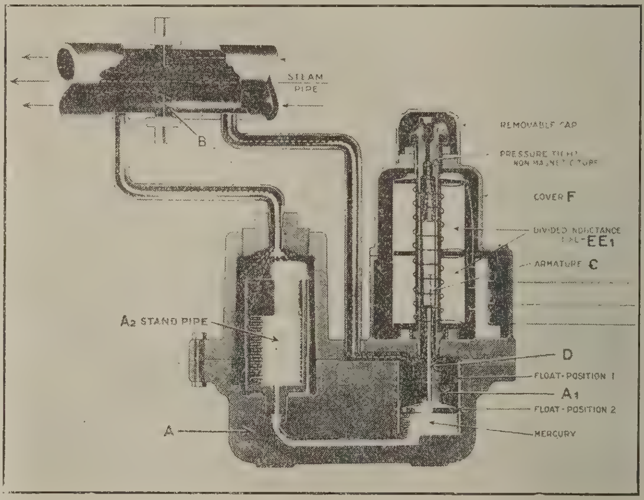
The single acting bearing consists of an upper race ring, one row of balls, a ball retainer and lower race ring.

The double acting bearing is virtually a combination of two single acting thrust bearings. It consists of a metal race ring, two rows of balls, two ball retainers and an upper and a lower race ring having either flat or spherical seats.

Improved Electric Flow Meter

By a novel but practical utilization of a well-known electrical principle, the design of the new Brown electric flow meter has avoided many of the difficulties previously encountered in flow meters.

As may be seen from the illustration, the manometer, *A,* operates in response to differential pressure caused by flow of fluid through an orifice, *B*. When the rate of flow increases, mercury is depressed in chamber A_1 and raised in Chamber A_2, the difference in mercury level in the two chambers being a measure of the rate of fluid through the orifice. When the flow increases from zero to a maximum value, the float which rides on the mercury surface in the chamber A_1 is lowered from the position indicated by the dotted lines to a lower position as indicated by the solid lines. The float is made of non-corrosive metal and Chamber A_1 has a molded Bakelite lining ribbed on the inside, insuring freedom of action at all times. An armature *C,* of transformer iron, is supported by the float on a non-magnetic rod *D.* and the armature is raised and lowered in accordance with the motion of the float. Through the three wires leading off to the right at a. c. circuit is connected which supplies energy to a divided inductance



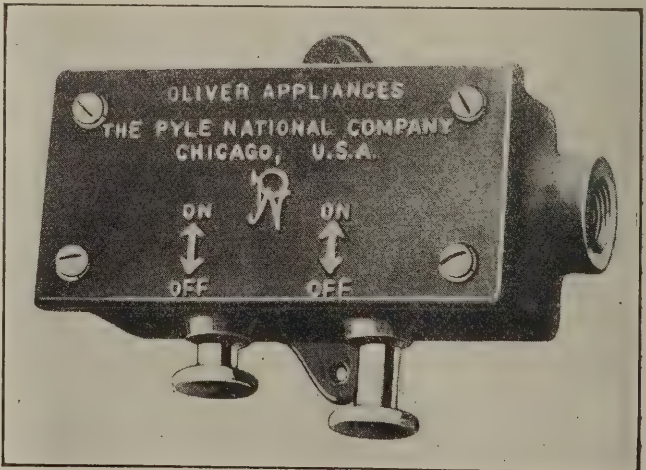
A Cross Sectional View of the Brown Electric Flow Meter

coil by virtue of which a continuous impulse is transferred to indicating and recording meters which are not shown in the illustration.

Push and Pull Switch

The new push and pull switch, illustrated, is intended for controlling classification lamps, tank lights, back-up lamp, or any similar electric lighting equipment.

The entire switch is of substantial construction; con-



Push and Pull Switch Type P S C 112

tacts and the operating mechanism are large and sturdy, the action is positive and with a quick make and break. Rating is 3 amperes at 250 volts, 5 amperes at 125 volts.

R S A standard terminals are provided, and the switch is arranged for easy wiring and mounting.

The housing has a cover held in place by four brass screws. It is weatherproof and dust-proof, and has two tapped entrances for standard conduit.

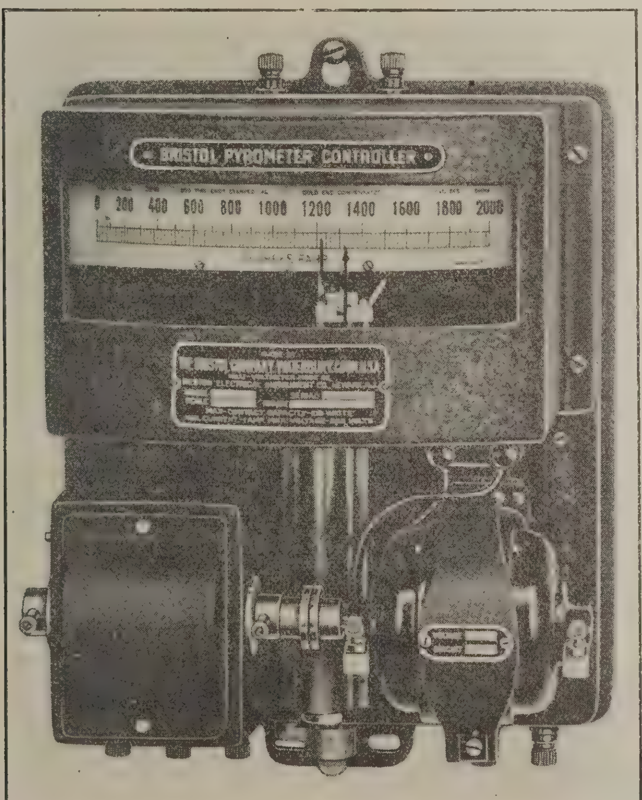
The push-pull type of switch gives a very positive action and a definite indication of the position. As will be seen from the photograph, the switch buttons are large and easily operated, and the travel is sufficient to indicate the position whether off or on.

The push and pull switch is type PSC-112 of the Oliver Electric Appliances manufactured by The Pyle-National Company.

Pyrometer Controller

A new pyrometer controller known as Model 479 has been developed as a result of four years experimental work by the Bristol Company of Waterbury, Conn. The new model has an extra wide scale 7 in. in actual measurement.

The governor used to regulate the speed of the driving motor, is reliable and positive in its action. All parts of



Bristol Pyrometer Controller No. 479

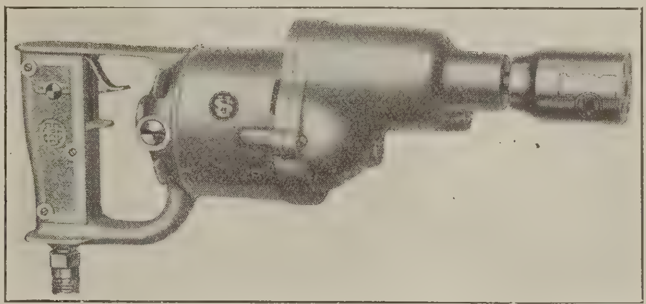
the governor mechanism and gears are accurately aligned and doweled to maintain permanent adjustment. The motor, with horizontal axis is connected to the driving shaft by means of a non-metallic coupling which reduces friction and noise.

A decided improvement is the adjusting mechanism for setting the position of the index at the point to which it is desired to bring the temperature.

Actual tests made with this new controller show that a movement of the pointer, which is too small to be observed with the naked eye, will decide whether a contact is made on the high or low side. This extremely close operation eliminates the need for partial or set-back scales.

Portable Die Grinding and Tapping Tools

Two portable electrical tools that have recently been added to the line of the U. S. Electrical Tool Company, are a die grinding tool and an electrical tapping tool. Both of these tools will operate on either direct or alternating current of 60 cycles or less when the voltage is within 10 per cent higher or lower than that marked on the name plate. Normally the tools are designed for

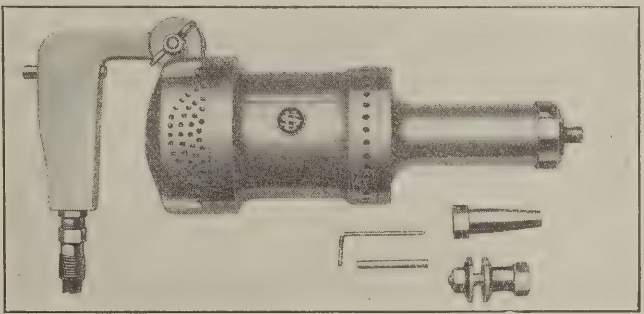


Portable Tappers Nos. 1 and 2

110-volt circuits, although they may be had for 32-volt or 220-volt operation if desired.

The die grinding tool is especially adapted for die grinding, grinding wheels, parts, fins of fine castings where speed and accuracy is required. An adjustable handle permits operation in close places and special adapters are also furnished to provide for the different sizes of wheels that may be used. The net weight of the grinder is 12 pounds.

The tapper is designed so that the chuck automatically



Portable Grinder

reverses when the operator gives a backward pull on the tapper. Special speeds of 500 r.p.m. or more at the spindle can be furnished if desired and a three-wire cable fitted with a three prong block for grounding tools can be fitted at a slight extra cost. The tappers are made in two sizes, Nos. 1 and 2, the latter having a slightly greater capacity. The respective weights of the two sizes are 7¾ and 9 pounds.

GENERAL NEWS

Graybar Electric Company announces the opening of its 59th distributing house located at Dayton, Ohio. The new sales and warehouse branch will be in charge of C. H. Dodt.

The American Locomotive Company has ordered from the General Railway Signal Company 10 sets of G. R. S. locomotive equipments for automatic train control on locomotives of the Michigan Central, and five sets for locomotives to go to the Boston & Albany.

A record for high voltage underground cable installation has been set by the New York Edison Company which has placed in service a cable carrying 120,000 hp. operating at 180,000 volts. This is approximately twice the voltage ever used on any similar cable previous to this installation.

Evan J. Parker, formerly of the Morgan Engineering Works, Alliance, Ohio, has joined the forces of the Northern Engineering Works, Detroit, Mich., makers of material handling equipment such as electric hoists, electric and hand cranes, foundry equipment, etc. Mr. Parker will have charge of the sales promotion division.

The International Railway Fuel Association has established an office in the Railway Exchange Building, 80 West Jackson Boulevard, Chicago. The office will be in charge of L. G. Plant, who was recently appointed secretary-treasurer, succeeding J. B. Hutchinson. All communications regarding the work of the Association, its publications, convention programs and arrangements should be addressed to 516 Railway Exchange Building, Chicago.

Representatives of the shop crafts of the International-Great Northern and representatives of the road organized a system board of adjustment for the differences which arise among employees and employers, at Palestine, Tex., on October 13. The employees and the management have equal representation on this board and the board will decide disputes growing out of personal grievances or applications of shop-crafts schedules and practices in cases which cannot be adjusted through customary channels.

The Interstate Commerce Commission has allowed the Chicago & Eastern Illinois an extension of time from November 1 to January 1 in which to complete the automatic train control equipment of its locomotives operating over the tracks of the Cleveland, Cincinnati, Chicago & St. Louis between Pana and East St. Louis, Ill. The latter is equipped with the General Railway Signal Company device and the C. & E. I., with the Miller train control of the ramp type and tests are being made to perfect an interchangeable device.

The Delaware, Lackawanna & Western has contracted with the Union Switch & Signal Company for the necessary apparatus to install automatic train control on the Scranton division, 270 miles of track. This, with the installation made under the first I. C. C. order, will make a total of 552 miles of track under automatic train control. The final total number of locomotives to be equipped will be 210. A new roadside pole-line for wires is to be built. With the completion of this work, this company will have expended about $1,500,000 on automatic train control.

Electrification of Brazilian Railway Proposed

The Ministry of Transportation of Brazil is reported to be considering the electrification of the Central do Brazil, work to begin before the end of 1926. The work of electrification will be commenced in the suburban district of Rio de Janeiro, and will be carried out for a distance of about 40 miles. The electrification will be financed by the national treasury. When the project was first considered in 1922, bids were offered by two American firms, and by two British construction companies, but were rejected by the government.

Interchangeability of Miller and G.R.S. Train Stop

Recent tests made by the New York Central on the high speed tracks east of Cleveland have shown that engines carrying receivers of the Miller alternating current type train stop also function correctly with the inductors of the General Railway Signal Company's automanual type. These demonstrations included tests up to full speed for passenger trains through air gaps up to 2½ in. with a lateral offset of 5 in. and 6 in. above with an air gap of 3½ in. with a lateral offset of 3 in. The receivers in these cases were 5 in. and 6 in. above

the rail level. A test was also made with an air gap of 1½ in. and a lateral offset of as much as 6½ in. The Miller receivers and inductors operate through 6 in. air gaps and comparable lateral offsets. Engines equipped with the Miller apparatus may, therefore, be operated over the Miller type of rail-level integrity-checking inductors on new installations without replacing the present auto-manual inductors now in service on previous adjacent installations.

Union Switch & Signal Company Acquires Right to Use Miller Train Control

A joint agreement has been entered into between the General Railway Signal Company, the Union Switch & Signal Company and the Miller Train Control Corporation whereby the two signal companies acquire the right to manufacture and sell the Miller train control systems and train-stop devices in the United States, east of the Rocky Mountains, and also in the Dominion of Canada.

The General company had previously obtained a license from the Miller company, as announced in June, 1926. At that time it was stated that the Miller organization would remain intact and had reserved the Chicago & Eastern Illinois, the Elgin, Joliet & Eastern and the Toledo-Detroit division of the New York Central; and the new agreement provides for the same conditions. It is understood that the Miller engineers will co-operate with the engineering departments of both signal companies. Since the agreement was first made with the General company, the Miller engineers have been working with the engineering department of that company in designing and perfecting plans for effecting interchangeability and standardization, and this work is now well in hand.

The Coder System

An installation of automatic train control on the Pennsylvania Railroad with a modification of the continuous automatic train control system has been installed by the Union Switch & Signal Company. This modified arrangement includes the "coder system," so called.

In this system the circuit by which impulses originating on the roadway are made to convey impulses to apparatus on the locomotive actuating the air brake system, is operated or controlled by a device working on a principle similar to that of the well-known selector, which is used in telephone train dispatching; apparatus by which the sending end produces effects at the receiving end by varied arrangements of impulses; or, in telegraph parlance, different combinations of dots and dashes.

Immediately on the opening of a switch in, or entrance of a train on to, any given track circuit the signal track current, governing the visual wayside signals, is practically de-energized and a 100-cycle alternating current, interrupted by a code transmitter, is submitted in the rail. This current is interrupted at definite rates (coded) in accordance with the condition of the signals and track circuits ahead. A similar current is induced in the receiving or pickup coils on the locomotive, which current, after being amplified in turn operates the apparatus which translates the varying rates of impulse into the indication which it is desired to display to the engineman; and by additional apparatus can be made to operate a whistle and to perform suitable functions related to an acknowledger, and a forestaller. Provision is made for one, two, three or four stages of speed control.

The absence of current, or a continuous current either a.c. or d.c., results in the display of a cab signal indicating slow speed.

A predetermined number of impulses causes the display of the approach signal, requiring the train to reduce speed and approach the next signal prepared to stop. A second code, giving a greater number of interruptions per minute causes the display of the approach restricting signal, requiring the train to pass next signal at restricted speed (usually 30 miles an hour). A third code, having a still greater number of impulses causes a display of the clear signal.

As the train leaves the circuit, the coded currents are cut off and the signal track circuit is restored.

Personals

Charles R. Sugg, electrical engineer of the Atlantic Coast Line Railroad Company, was elected president of the Association of Railway Electrical Engineers at the seventeenth annual convention of the Association held in Chicago on October 26. Mr. Sugg was born in the township of Greenville, N. C., and his boyhood days were spent as a page in the lower house of the North Carolina State Legislature. In 1893, he was made chief page of the North Carolina State Senate.

C. R. Suggs

Later he went to Washington, D. C., where he became a messenger in the government printing office. While in Washington, Mr. Sugg studied electrical work at the Bliss Electrical School from which he graduated in 1899. He then attended the George Washington University from which he was graduated in 1906, with a degree of electrical engineer. Mr. Sugg was appointed acting superintendent of buildings at the government printing office in the spring of 1908, in which position he had full charge of the mechanical department. On February 1, 1909, he accepted a position as electrical engineer with the Atlantic Coast Line Railroad Company which position he has held continuously since his appointment.

R. E. Hellmund, formerly supervisor of development in the engineering department of the Westinghouse Electric & Manufacturing Company, has been appointed to the newly created office of chief electrical engineer. In this position his activities will be principally in connection with electrical development work to assure the adequacy and progressiveness of designs and to coordinate properly this work throughout the different engineering departments. Mr. Hellmund was born in Gotha, Germany, on February 2, 1879, and graduated

from the college of Illmenau in 1898 with a degree of electrical engineer. He entered the employ of the Westinghouse Company in 1907, as a designer of induction motors. Later he was engaged in general engineering work and in 1912, was placed in charge of the design of all direct current and alternating current railway motors. In 1917, he was given miscellaneuos consulting work which continued until 1921, when he was appointed engineering supervisor of development, which position he held until the time of his recent appointment.

J. E. Waterbury, formerly illuminating engineer with the Tri-Cities Power Company, has recently been placed in charge of the illuminating engineering department of the Benjamin Electric Manufacturing Company. Earlier in his career, Mr. Waterbury was connected with the engineering department of the National Lamp Works for a period of six years. While in this position he was a co-inventor and designer with Ward Harrison of the "Glassteel Diffuser."

W. H. Fenley, western sales manager of the Kerite Insulated Wire & Cable Company, was elected president of the Railway Electrical Supply Manufacturers' Association on October 28, at the annual meeting of the Association held at the Hotel Sherman in Chicago. Mr. Fenley entered the railway service with the Cleveland, Cincinnati, Chicago & St. Louis Railroad in 1895, with which company he remained for three years, being yardmaster at Greensburg, Ind., during the latter two. In April, 1898, he entered the service of the National Switch & Signal Company with which company he was engaged in construction and maintenance work until June, 1900, when he entered the employ of the Chicago Great Western at St. Paul, Minn. During the next ten years he was successively foreman, inspector, office engineer, supervisor and signal engineer of that road, having been promoted to the latter position on February 9, 1908. He also acted in the capacity of consulting engineer for the McClintock Signal & Supply Company during 1906 and 1907. He left in 1910 to become a sales engineer of the Union Switch & Signal Company with headquarters at Chicago, which position he held until August, 1911, when he resigned to become signal engineer of the Panama Railroad. On September 16, 1913, the telephone, telegraph and signal departments of this road were consolidated and Mr. Fenley was appointed superintendent of the combined organization. He resigned in June, 1915, and was appointed sales agent for the Kerite Insulated Wire & Cable Company and in 1922, he was promoted to western manager of the company with headquarters at Chicago.

W. H. Fenley

A. M. Dudley, formerly manager of automotive equipment, engineering department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed to the position of engineering supervisor of development, recently vacated by R. E. Hellmund. Mr. Dudley was born in Cincinnati, Ohio, in 1877 and graduated from the University of Michigan in 1902, with a degree of Bachelor of Science in electrical engineering. He entered the service of the Westinghouse Company as an apprentice in 1904, and shortly afterwards was given a position in the company's engineering department where he engaged in the design of alternating current motors and controllers. Early in 1906, Mr. Dudley was made commercial and general engineer with the industrial and power sales department. In 1907, he was placed in charge of the alternating current motor section and continued in this position until 1918 when he was placed in charge of the starting, lighting and ignition equipment for automobiles. In 1920, he was made manager of the automotive equipment engineering department, which position he held until 1924, when he was appointed to assist Mr. Hellmund in his work as engineering supervisior of development.

W. B. Flanders, engineer, large turbine division of the engineering department at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company, has been appointed assistant manager of engineering. R. C. Allen, assistant to chief engineer, has been appointed manager of large turbine engineering. J. A. MacMurchy, engineer, small turbine division, has been appointed manager of small turbine engineering, and D. W. R. Morgan, engineer, condenser division, has been appointed manager of condenser and internal combustion engineering.

Trade Publications

Direct current crane and hoist motors, type CO-1820, are explained and illustrated in a recent bulletin issued by the General Electric Company. Exploded views are shown in which all of the principal advantages of this equipment are pointed out.

Chicago Steel & Wire Company, Chicago, Ill., has recently issued a small 12-page booklet entitled "A New Viewpoint on Metallic Arc Welding Costs." The booklet is chiefly concerned with a new green surfaced welding rod which the company is manufacturing.

Ceiling Fans for Postal Cars is the title of a booklet recently brought out by the Safety Car Heating & Lighting Company. The booklet contains 16 pages. It is illustrated with diagrams and is intended as a supplement to Postal Car Lighting of 1925, covering the subjects of conduit, wiring and fixture installations.

The Westinghouse Electric and Manufacturing Company has just issued a 112-page publication describing switching equipment for alternating current power stations. This publication, 1541-C deals with the general fundamentals in laying out a switch board, and describes the various types of switching equipment. It is well illustrated with diagrams and half-tone illustrations.

Railway Electrical Engineer

Volume 17 DECEMBER, 1926 No. 12

Results of the Kink Contest

The three prizes offered by the *Railway Electrical Engineer* for the best two electrical kinks have been awarded as follows: First prize, H. M. Watson, Deer Lodge, Montana; second prize, H. N. Griffin, Minneapolis, Minnesota; third prize, H. A. Leatherman, Cleveland, Ohio. All of the six prize winning kinks are published in the Interchange Section of this issue and readers will undoubtedly agree that the devices described are good ones.

The judges in the contest were five electrical engineers with railroad experience; they found it a difficult task to make the selection. Among the kinks submitted are many that show the same sort of ingenuity as the prize winners and in the final analysis it was necessary to select as prize winners, kinks which could be used by the greatest number of men in different branches of railroad work. Some very good devices were excluded from consideration as prize winners because only one kink was submitted and the prizes were offered for the best collection of two kinks.

It is up to the man in the shop to find ways and means of doing his work well and with the least amount of effort. Shop men come in contact with each other so little that two shops located near together even on the same railroad, frequently do the same work in two entirely different ways. One method is better than the other and when that method is known in both shops, the inefficient method usually disappears.

The purpose of the Interchange department is to provide a means whereby the men who do the work can interchange ideas. Contributions are paid for at regular space rates and each one that is published is a boost for the electrical game and a help to some other man. Following issues will contain other kinks submitted in the contest, but that is no reason why readers should not continue to contribute to the department. There is always space for a good idea and a check for the man who sends it in.

Two-Phase Motors For Three-Phase Operation

A comprehensive article on the subject of changing motors from two-phase to three-phase service, by Charles R. Sugg, electrical engineer of the Atlantic Coast Lines, appears in another part of this issue. Mr. Sugg has prepared this article with care and it is the embodiment of practices which he has found useful and which he has successfully applied to many motors on his own road.

Some of the readers of the *Railway Electrical Engineer* may look askance at the numerous mathematical formulas presented, for as a general rule not many articles involving mathematics find their way into the pages of this magazine. In this particular case, however, the information is of unusual value.

Existing two-phase circuits are changed to three-phase whenever possible. There are many two-phase motors still in use, however, and on some roads the number is so great that it has practically precluded the use of anything but two-phase circuits unless the present motor equipment can be changed in some relatively simple manner from two- to three-phase operation. The article gives this information in full detail; it is not merely a theoretical discussion of the subject but a description of a practical method which has been tried and found to give excellent results. By following Mr. Sugg's reasoning, it will be seen that two-phase motors can be changed for three-phase operation with a surprisingly small loss of efficiency.

Train Lighting Voltages

Whether a 32- or 64-volt is a proper potential to use for suburban train lighting when the current is furnished from a turbo-generator mounted on the locomotive, is a question upon which various opinions are held. The 32-volt system which has been standardized for practically all axle lighting equipment has certain advantages, the principal one of which is the use of one standard voltage for all types of equipment. A number of the larger roads operating suburban trains into Chicago, however, use a 64-volt system and find that this gives entire satisfaction. This, of course, continues the 64-volt lamp as another standard to be maintained. In certain respects the 32-volt system is more flexible since it permits the interchange of axle lighted cars with those ordinarily supplied with current from the locomotive turbo-generator. Whether or not this feature may be considered as an advantage depends entirely upon the desirability of making such an interchange.

The 32-volt system naturally involves a greater voltage drop for the same size of train line wires than does the 64-volt system, but those who have installed the 32-volt system feel that this loss is more than offset by the advantage of reduced maintenance.

As a matter of fact, it is quite possible to use 32-volt lamps and at the same time retain the advantages of smaller line loss which accrue from the use of 64 volts. The wiring can be arranged in such a way that merely throwing a switch in one direction or the other, 32-volt

lamps may be used on either system. This has been done to some extent and has proved satisfactory when proper switching arrangements have been installed.

The present voltages for car lighting have been in use for many years. Practically all of the generating equipment has been built up around these voltages and there is nothing to indicate that any material change will be made in these voltages in the near future. Both the 32-volt system and the 64-volt system have found supporters and the probability that either will be changed to the other is rather remote. To force the adoption arbitrarily of one of these voltages to the exclusion of the other, would be impossible and undesirable. Each has its place in the present practice of car lighting and until some radical change is made in lighting methods, both systems will continue in use.

Transportation and Electrical Development

Manufacturing industries are to be decentralized and railroad requirements will be radically changed if the prophecy made recently by three speakers before the New York Railroad Club is fulfilled. The subject under discussion was the "Relation of Transportation to Electrical Development" and the three speakers were John C. Parker, vice-president, Brooklyn Edison Company; F. Darlington, assistant to vice-president, Westinghouse Electric & Manufacturing Company, and Colonel J. P. Jackson, assistant to vice-president, New York Edison Company. All the speakers were agreed on the main points of the question which are outlined in the following paragraph:

Good transportation facilities were developed long before there were adequate means of transmitting electric power. The result was that large manufacturing centers were developed, many of which specialized in the manufacturing of one kind of product. In such centers, wages are high but living costs are also high and temporary slack periods in industries create hardship among the workers. In smaller communities where there is greater variety of work, daily wages are lower but the annual income is often greater and cost of living is less. Today power can be had almost anywhere. Power and standardized manufacture permit the making to advantage in small towns of parts, as for example, the component parts of automobiles, these parts being shipped to assembly plants.

Upon this premise, the speakers made the prophecy that in the future, many manufacturing plants will move to smaller towns and that there will be a diversity of manufacture in each of these towns. Actually such a change is already in progress. The LaSalle Extension University Bulletin for December, 1926, contains the following statement:

"In the central west and in the south, the small towns are becoming more and more the sites of manufacturing plants, because of the cheap yet efficient labor available and practical freedom from labor troubles. These small-town local plants, however, are usually controlled by, or are a part of, large organizations in a not-too-far-away great city. The larger organizations make all the sales, oversee the plant and take care of all the overhead expense."

If this change is carried out according to prophecy and present indications, it will alter considerably our present transportation requirements. Raw products will continue to require long hauls, the movement of coal will probably be reduced and the amount of short-haul traffic will increase. It will stimulate the use of rail-motor cars, highway vehicles and other forms of transportation. It will be necessary to co-ordinate the various forms of transportation in such a way as to best serve the public needs. Similarly there is a need for co-ordinating transportation developments with power developments.

Electricity plays an important part in all modern means of transportation and has been largely responsible for the development of new transportation methods and equipment. It will probably play a much more important part in future developments. "Much water will flow over the dam" before the Railroad Club speakers' prophecy will be realized extensively, but the subject is a live one and the information already available indicates a trend which is of interest to those whose work has to do with electrical equipment used in the business of transportation.

New Books

Principles Underlying the Design of Electrical Machinery. By W. I. Slichter. N. Y., John Wiley & Sons, 1926. 312 pp., illus., diagrs., tables, 9 x 6 in., cloth. $3.75.

Contents: General principles and fundamental relations.—Continuous-current generator.—Salient-pole alternating-current generator.—Turbine-driven alternating-current generator.—Transformer.—Induction motor.—Index.

Dr. Slichter's book is developed from a course of lectures given at Columbia University and from his experience as a designing engineer. It is to some extent an amplification of his articles on the subject written for Pender's "Handbook of Electrical Engineering."

The purpose throughout is to give a practical method of design, with explanations of the physical meaning of the arbitrary constants used by the professional designer. To assist in this, the author derives the formulas from fundamental principles, explains each of them and gives the reasons for the various standards of practice. He gives a systematic method of procedure for the design of each type of machine treated, with a complete sample calculation in each case.

The book is intended as a text for a course on design. It will also be an aid to young engineers through its explanation of the reasons for certain conventional practices.

Electrical Machine Design. By Alexander Gray, revised by P. M. Lincoln. 2d Edition, N. Y., McGraw-Hill Book Co., 1926. 523 pp., illus., diagrs., 9 x 6 in., cloth. $5.00.

The reviser has retained Professor Gray's presentation of fundamental principles and his methods of analysis without modification. He has taken account of the development that has occurred in electrical machinery in the past fourteen years and has modified the example machines so that they represent current designs and changed the various curves, tables, illustrations and other data to conform with the modern or present day practise.

The Cedar Hill Yard of the New Haven as It Looks in the Daytime

Floodlighting of Railroad Freight Yards*

General Principles, Power Requirements, Data Covering Costs and Advantages of Yard Illumination

By George T. Johnson
Assistant Electrical Engineer, New York, New Haven & Hartford

LIGHTING of railway classification yards is a problem of space lighting, the length of yards varying from 3,200 ft. to 6,500 ft., the width from 400 ft. to 650 ft., and the distance from the hump to the last switch on the ladder, from 1,300 ft. to 1,800 ft. in our modern yards,—all depending upon the capacity of the yard. Ten tracks generally diverge from each ladder track. The space between the ladder tracks is used for the speeder cars which carry the hump riders back to the hump after cars have been brought to rest in the classification yard. In the case of a yard where car retarders are used, this space could be utilized for pole lines carrying a lighting distribution system.

No work other than the classification of cars is performed in the modern clasification yard, the air testing and inspection being performed in the departure yard,

*Abstract of a paper presented before the New York regional meeting of the American Institute of Electrical Engineers, November 12, 1926.

Night View of the Cedar Hill Yard of the New Haven—Two of the Poles Shown Are a Part of the Old Lighting System and Will Be Removed

and consequently there is no necessity for local or intense illumination.

The ladder tracks of classification yards are seldom built on curves; in fact, in yards where retarders are used, the curvature is limited to six degrees. Therefore the problem of curved track lighting need not be considered.

There are two adjuncts to a modern classification yard; namely, the receiving yard and the departure yard. No illumination is ordinarily required in these other than that which is necessary for police protection or in cases where short trains are pushed into the receiving yard on the same tracks or diverging tracks, for the storage of previous trains. In some instances, however, where receiving yards are built with considerable curvature, there is an advantage in providing sufficient illumination to enable engine drivers to observe their respective courses.

The tracks connecting the classification and departure yards, covering a distance varying from 400 ft. to 700 ft., require local illumination. The most effective means of providing this illumination is by the angular type of reflector, with the beam of light directed in such a manner as not to affect the vision of the engine driver who is required to cover these tracks and who is frequently unable to obtain the benefit of the locomotive headlight because of the curvature of tracks and on account of switches. With the angular reflectors giving a wide beam, the proper spacing is about 100 ft. for 300-watt lamps at an elevation of 22 ft. above the tracks. A similar type of lighting should be installed at the hump for the benefit of the car riders. The departure yard, as stated above, requires very little illumination other than that necessary for police protection. The inspectors are required to work under cars and between long lines of cars on adjacent tracks and therefore they carry lanterns. Moreover, it would be impractical and expensive to attempt to provide illumination for their benefit, and it would be impossible to show any financial saving or reduction of personal injury hazard.

Floodlighting Is Most Easily Adopted to Yard Requirements

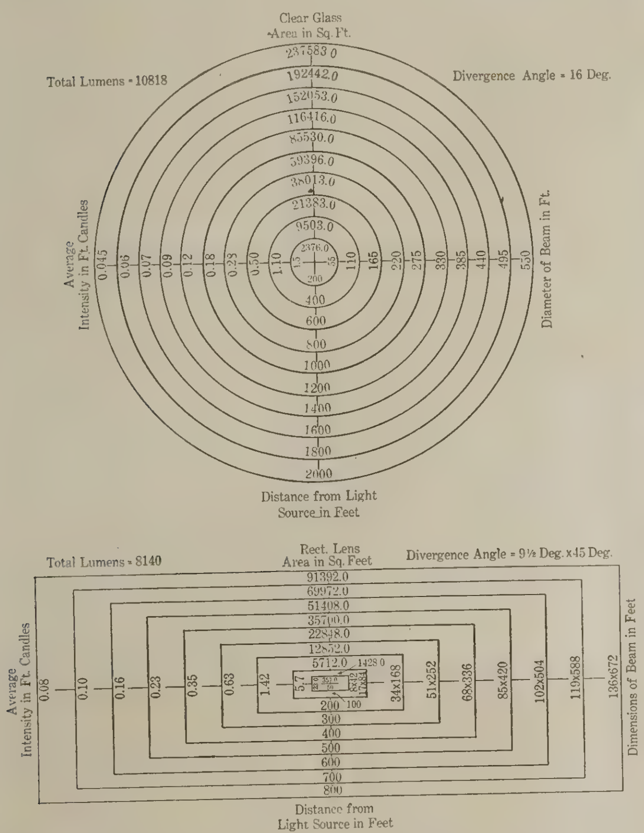
Good illumination requires an even distribution of light without glare. In order to obtain this condition, lamps must be so spaced and so placed that there is no interference with one's vision. As space is valuable in

Yard Equipped with Car Retarders, Showing Lighting Tower at the Right

a railroad yard, and as the expense of installing and maintaining such an installation is extremely heavy, we have been compelled to seek some other solution of the problem. The method commonly used is the installation of towers 75 ft. to 120 ft. above the base of the rail, with a number of projectors equipped with 750-watt or 1,000-watt lamps mounted on a platform at the top of the tower. The protective apparatus and switches are installed at the base of the tower in order to avoid all unnecessary maintenance labor. Practically the only necessity for climbing the towers is to change lamps and clean lenses and reflectors, which it is rarely necessary to do more often that every three months in winter and

Illustration of Visibility Secured by Silhouette and Specular Re‑ection from the Rails and Sides of Cars

less frequently in summer. It is advisable to place control of the lighting in charge of the hump tower operator. This may be accomplished by installing a small start and stop button in a selected position, the manipulation of which energizes and de-energizes a contactor installed at the lighting tower. Another method is to install time switches at the base of towers which will automatically turn the lamps on and off at a predetermined time. The first method of control enables the tower operator to practice economy in current consumption during slack hours and yet furnishes sufficient light



Illumination From 1000-Watt Lamp in Floodlight Projector with and Without Rectangular Lens—A PS-52 Bulb Was Used

for police purposes. Tower lighting permits adjusting the position of the towers with the result that if space is not available for an ideal location, a change of 100 ft. or even 200 ft. does not materially decrease the efficiency of the installation. There is a possibility (although rarely available in classification yards) of taking advantage of high structures such as coal pockets and bridges for mounting projectors.

Classification yard lighting may be divided into three general classes or types, each requiring a different solution, as follows:

1. Yards employing hump riders and having hand-operated switches.

2. Yards employing hump riders and equipped with automatic switches.

3. Yards equipped with automatic switches and car retarders.

Yards Having Hand Switches and Employing Hump Riders

With the first type of yard, extreme care must be exercised to prevent interference with the switchman's vision on account of glare, as this is likely to be the cause of personal injury or accidents to the equipment. If space is available, two towers may be installed one on each side of the hump and 300 ft. apart. If lack of space at the hump makes this impracticable, a so-called "modified distribution system" is advisable and the towers may be installed on the outer edges of the classification yard in conjunction with 300-watt angular reflectors mounted on poles in the space occupied by speeder tracks which provide illumination in the area between the hump and the point where the tower lighting becomes effective. In very narrow yards it may be found desirable to install 500-watt projectors with a 250-ft. spacing and an elevation of from 35 to 40 ft. above the tracks, the necessary pole line being installed in the speeder car space. This latter method does not permit expansion and involves high maintenance costs as well as interference with the operators' vision by the poles; therefore it should not be installed. The cost of installing two towers at the hump amounts to approximately $7,000,

Two 70-Foot Towers, Each Equipped with Eight 1,000-Watt Projectors and Located Close to the Hump Used for Lighting the 3,200-Foot Cedar Hill, Conn., Yard of the New York, New Haven & Hartford

and involves a low maintenance cost, whereas the "modified distribution system" costs at least $8,000 to install and results in a high maintenance cost.

With the second type of yard it is not necessary to consider the glare as there are no men in the yard and the current of traffic is in the direction of the light beam. One or two towers may be installed in the same relative position as in the first type of yard, or, if space is not available at that point, they may be installed close to the hump. The cost of these towers will be approximately $7,000. For a 3,200-ft. yard no other lighting is required for the classification yard, an unobstructed

view being obtained both from the hump and by the car riders. The power required for a 40-track yard is approximately 16 kw. The installation and maintenance cost is low. The maximum illumination is at the switches, and the hump rider is enabled to detect track conditions clearly; moreover, in distant parts of the yard sufficient illumination is provided to permit the observation of low built cars in time to avoid collision with them.

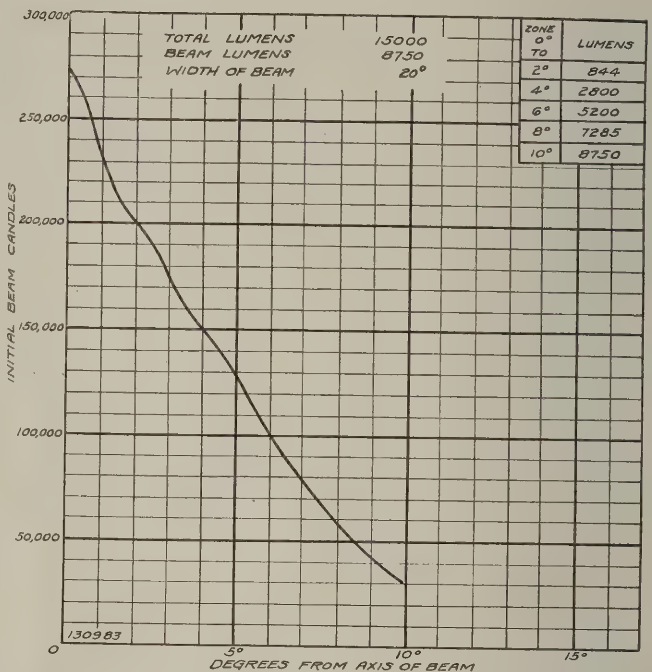
Yards Having Automatic Switches and Employing Hump Riders

Where yards are of extreme length it will be necessary to place at least two towers approximately 2,000 to 3,000 ft. from the hump in the year, or where space is not available for this, the towers may be installed on the outer edges of the yard at the same distance from the hump. The wattage requirements for a 3,200-ft. yard are from 12 kw. to 16 kw. and decrease proportionately as the yard decreases in length. The increase in installation cost for a 6,000 ft. yard over a 3,200-ft. yard will amount to approximately $12,000, making a total installation cost of about $19,000, with a maintenance increase of slightly over 100 per cent. There is some possibility that at some time in the future, lamps of higher wattage may be used in the 5,000- and 6,000-ft. yards, with a resultant reduction in the number of towers required and a decrease in the installation and maintenance costs, but in considering any such proposition the possibility of interference with the vision of adjacent interests must be taken into account.

The third type of yard is similar to the first, but the personal injury hazard is eliminated as no hump riders or switchmen are required in the yard.

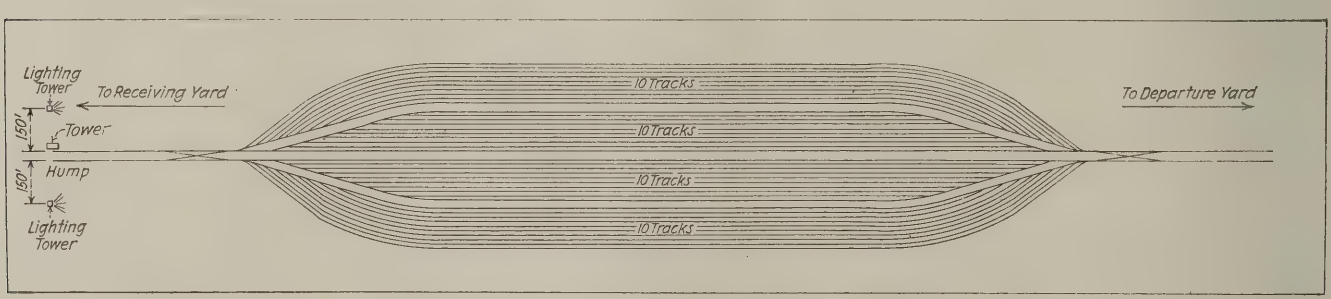
Yards Equipped with Automatic Switches and Car Retarders

The retarder operators are located in secondary towers situated adjacent to the groups of retarders which they control. These towers are in the area of the ladder switches and are at an elevation above the tracks which permits an unobstructed view of the yard. Up to the present time no economical solution of this problem has been worked out. If lighting as recommended for the second type of yard is installed, the glare interferes with

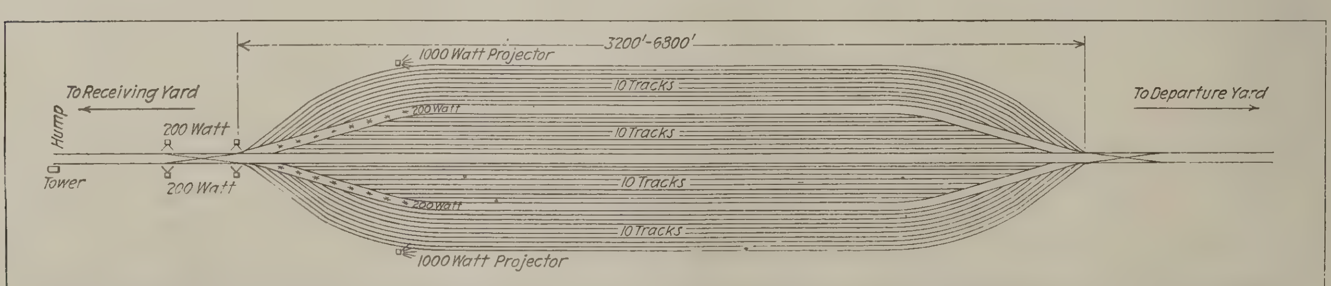


Illumination Curve of Floodlight Projector with 1000-Watt, 115 Volt, Mazda C Lamp with PS-52 Bulb

the vision of the operators. In this connection it is possible that a visor effect may be obtained by painting the upper part of the tower windows, thereby shutting off from the operators' vision the glare resulting from the direct beam of the lights.



Typical Lighting with Towers Located at the Hump



Modified Lighting System Where Space at Sides of Hump Is Scarce

The position of retarders with respect to the operator is frequently such that it is difficult for the operator to observe the exact position of moving cars and of retarders at night on account of shadows. A possible solution of this problem may be found in "marker lights" so placed that they will indicate when the braking effect on cars is to be applied to the retarders. This solution of the problem would be very economical.

Any system of local illumination covering retarder areas would be expensive and is something that would cause interference with track clearances, which must be avoided.

With the increased experience of retarder operators there will be no necessity for illumination greater than that provided in yards using hump riders and automatic switches, since each operator will know the loading condition of his tracks and will be governed accordingly. The same problem presents itself in lift-bridge operation, where actual practice has demonstrated that the experienced operator knows the position of his bridge at night and does not watch the indication lights, but prefers a marker light so placed that it will not be necessary for him to direct his attention in another direction.

Advantages of Yard Lighting

The committee on illumination of the Association of Railway Electrical Engineers in November, 1923, reported the following advantages of yard lighting:

1. Speeding up of cars handled in the yard at night.

2. Reduction in cars damaged by rough handling and collision in the classification yard with consequent reduction in claims, delay in delivery of goods, loss of service of damaged cars, etc.

3. Reduction in losses due to pilfering on account of more effective policing possible with a well illuminated yard.

4. Improved working conditions and increased safety for employees working in the yard.

The studies and investigations of the committee on illumination in conjunction with the lamp and projector engineers, although not as yet completed or published, have already resulted in more efficient units and more economical installations. The problem of lenses deteriorating with age, with resultant decrease of efficiency, has been practically solved. Curves and engineering data are now available which makes it possible to plan installations with confidence that the results anticipated will be achieved. The problems of space lighting may be solved in various ways on account of local conditions, but the fundamental principles are the same in all instances.

Floodlighting is not a "cure-all," but the results are satisfactory to the operating people and provide for them the operating conditions which they have been seeking.

No mention has been made in this discussion of silhouette effect, since it is considered that while theoretically this feature may have some value, at the present time the effect on the vision due to glare more than offsets the benefits.

Further studies will be necessary before this type of installation can be recommended.

Pulverized Fuel Installations

By J. H. Wickman

Mechanical Engineer, The Newport Co., Milwaukee

While the design and installation of power house equipment does not come under the direct supervision of many electrical engineers employed by the railroads, there are quite a number that are responsible for these installations and no doubt a great number are at least interested. The factors of sizes of the individual pulverizing units, combustion space, wall design, burners, CO_2 control and fuel no doubt may seem quite complicated to those who have not had the practical experience of handling many installations utilizing powdered fuel.

Pulverizer and Combustion Space

Judging from the number of installations made during the past two years, there is but little doubt that an individual pulverizer is the more economical, both from the standpoint of first costs and operation costs. By individual pulverizer we mean a pulverizer for each boiler setting. There are several factors as follows, in favor of the individual pulverizer over a plant pulverizer system.

1. When considering a plant having 20,000 hp. of boilers or less, should one of these pulverizers be down for repairs, by accident or lack of driving power, only a small portion of the whole would be crippled.

2. The first cost is materially less on account of no storage space being required, thereby saving building costs, car handling equipment, conveyors and auxiliary crushing equipment.

3. Better and more flexible control of the fires and no danger from premature explosions from dust in the storage bins.

The correct size of individual pulverizer to install is based entirely upon the local operating practice. It has been the writer's experience that a boiler is seldom operated at over 250 per cent of its normal rating and all of the pulverizers we have installed have been purchased with this in view, of course if a plant has a fixed policy never to operate at over 200 per cent normal rating a smaller pulverizer should be used, but it is necessary to decide this before making an installation because it is very important to proportion the combustion space to the horsepower rating of the boiler.

In checking several installations it was found that a rather "hit and miss" method must have been used when laying out some of the older installations, as the ratio of horsepower to combustion space varied from one horsepower to 2½ cubic feet of space to one horsepower to 6 cubic feet of space, of course, the plants having the greater ratio, that is, one to six, were much better off as they would be able to operate the boilers at a higher rating. The following table shows about the correct proportion for economical and efficient operation of boilers, without ventilated or water cooled sidewalls.

Boiler Rating	Combustion space in cubic feet per horsepower
100 percent	4 to 4½
150 "	4
175 "	3½
200 "	3
250 "	2.75

The pulverizer specifications should call for a certain continued fineness of pulverization, which should be at least 70 per cent through a 200 mesh screen, 90 per cent through a 100 mesh screen and 100 per cent through a 50 mesh screen.

Burners

The location of the burner supplying the furnace is very important, and if space can be had there is no doubt, the ideal location is to feed the furnace through the top, as it adds to the combustion space, this being better than having it located in the front wall of the boiler, as when the boiler is thus located there is a dead space between the top of the burner and the bottom of the top arch of the boiler, which in nearly every installation examined amounted to at least one half of one cubic foot per boiler horsepower.

There has been some argument about the burner overheating if located in the top of the furnace from reflected heat, however, this is easily overcome by water-jacketing the last section of the burner piping. Locating the burner in the top of the furnace also leaves a greater distance between the end of the burner and the bridge wall which is an added advantage of saving the bridge wall setting.

Wall Design and CO_2

The wall design of the furnace is also another factor that depends upon the rating that a boiler is to operate. If it is to be run at a rating of 175 per cent or over a ventilated or water cooled side wall would be recommended, but if only operated at normal or up to 175 per cent there is no occasion to install anything more than the usual practice requirements. It is commonly admitted under most any condition whether the installation is designed for powdered fuel or stoker feed that the side walls can be burned down by not supplying enough air into the combustion chamber, this condition, of course, will be indicated by the CO_2 recorder which will record very much higher than usual. This last statement may be better understood if it was explained that when referring to air, we do not mean the air entering with the powdered fuel, but that entering through the port holes in the front and near the bottom of the combustion chamber. However, if ventilated sidewalls are used and heated air from the ventilating ports is used through the burner there is more danger of overheating the side walls and burning them down.

By using the CO_2 recorder as an indicator of the furnace temperature, as well as an excess air indicator it has been found that it is not safe to operate at a per cent to 15 per cent of CO_2 without ventilated or temperature which would correspond to higher than 14 water cooled side walls, that is, if the CO_2 recorder registers higher than 15 per cent it is fairly safe to assume that the furnace temperature is too high and should be lowered by admitting more air through the ports into the boiler furnace until the CO_2 recorder register under 15 per cent.

Fuel

One of the first main arguments for pulverized fuel was to burn a lower grade of coal more economically; however, the several plants investigated are using a higher grade than they were formerly with stokers. The writer has inspected several plants and is now operating two pulverized fuel plants where the residue pitch from the distillation of coal tar is being used as fuel. This pitch comes to the plant in sizes not to exceed 1½ in. to 2 in. to dust and requires no further pulverization before entering the powdering pulverizer, however, it passes through the unloading pit pulverizer formerly used for coal crushing, as no changes were made in the handling of pitch except the installation of a magnetic separator to pick out the tramp iron. This pitch runs 16135 B.T.U.s per pound with practically no moisture, ash or sulphur and is very brittle, however, the melting point is low, varying from 285 deg. to 310 deg. Fahrenheit.

The following are a few results obtained from daily run sheets using powdered pitch:—

Boiler Hp. Normal Rating	Percent of Normal Rating	Water Evaporated Per lb. of Coal	Steam Pressure in lbs.	Superheat Degrees Fahr.	Factor of Evaporation	Water Evaporated from and at 212 Deg. per lb. of Coal
402	143	10.9	200	100	1.222	12.229
402	147	10.45	200	77	1.1069	11.567
402	161	10.47	200	77	1.1069	11.59

With fifth vein coal screenings running at 10,000 B.T.U.s or thereabout, per pound run under the same condition, while operating at 157 per cent rating we are able to show water evaporation from and at 212 deg. of 9.91 pounds per pound of fuel used, which is a good argument for pulverized fuel.

A Few Crossing Gates—Crossing of the D. T. & I. at Oak Street, Wyandotte, Mich. Three Unnamed Crossings in the Background

One of the Motor-Generator Electric Locomotives for the Great Northern

Great Northern Electrification Progress

Twenty-five Cycle Current Will Be Used on the Trolley But Direct Current Will Supply Driving Motors

TESTS have been run on the first of two motor generator type locomotives built for the Great Northern by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company and the locomotive was shipped from East Pittsburgh, Pa., on November 20. The present undertaking involves the revision of the original electrification between Tye, Wash., at the western end of the Cascade Tunnel and the eastern portal of the same tunnel, and the extension of the electrification westward to Skykomish, Wash. The electrified mileage will thus be increased from four miles to 24 miles of main line trackage, exclusive of yards.

This electrification project constitutes what is reported to be the first step in a program that will include 96 miles of main line via a new tunnel, from Gold Bar to Wenatchee.

By eliminating the duplication of helper service, the delays caused thereby, and other losses of time incident to steam operation such as watering, refueling, standby losses, etc., the electrification is calculated to bring material savings in operating costs. In addition, it will permit faster train movement over the section involved and will virtually fulfill in every respect the requirements of present operating conditions. Consideration has been given to future requirements by an ample allowance for expansion.

In order to secure the advantages of alternating-current transmission and trolley and the direct-current traction motors, the motor-generator type of locomotive was chosen. This will draw power from an 11,000-volt single-phase, 25-cycle trolley. By using this type of locomotive it is possible to take advantage of the inherent merits of both the alternating-current and the direct-current systems. This means high-voltage transmission to the locomotives with minimum copper loss and power loss, static unattended transformer stations along the railway line, light overhead construction, plus the advantages of direct-current traction motors and practically unlimited flexibility of control in operation and regeneration.

Conditions Governing Operation

The main line of the Great Northern which extends from St. Paul, Minn., to Washington, has the lowest ruling grade to the Pacific coast of any of our western railroads. The line is laid with heavy rails and is double-tracked at most of the critical points. The heaviest and most severe grades against load movement are encountered in crossing the Cascade mountains in Washington, where the line is single track. Here the rise to the summit on both sides is very precipitous, and on the west slope a very circuitous route is required to make the ascent. Many snowsheds are required to shelter this section of the line from the deep snow and slides during the winter season.

There are several tunnels along the circuitous route on the western slope, the longest of which is the Cascade tunnel, at the summit. This tunnel, constructed on a 1.7 per cent grade, is about 2.75 miles long. The original electrification which is now undergoing modification, was installed through this tunnel in 1909, mainly for the purpose of eliminating gas and smoke so as to expedite train movement. It extended from Tye at the west portal to Cascade Tunned Station at the eastern portal, and comprised four miles of main line track and

four miles of yard trackage. The 6600-volt, a-c. three-phase, 25-cycle system was used with a double overhead catenary trolley.

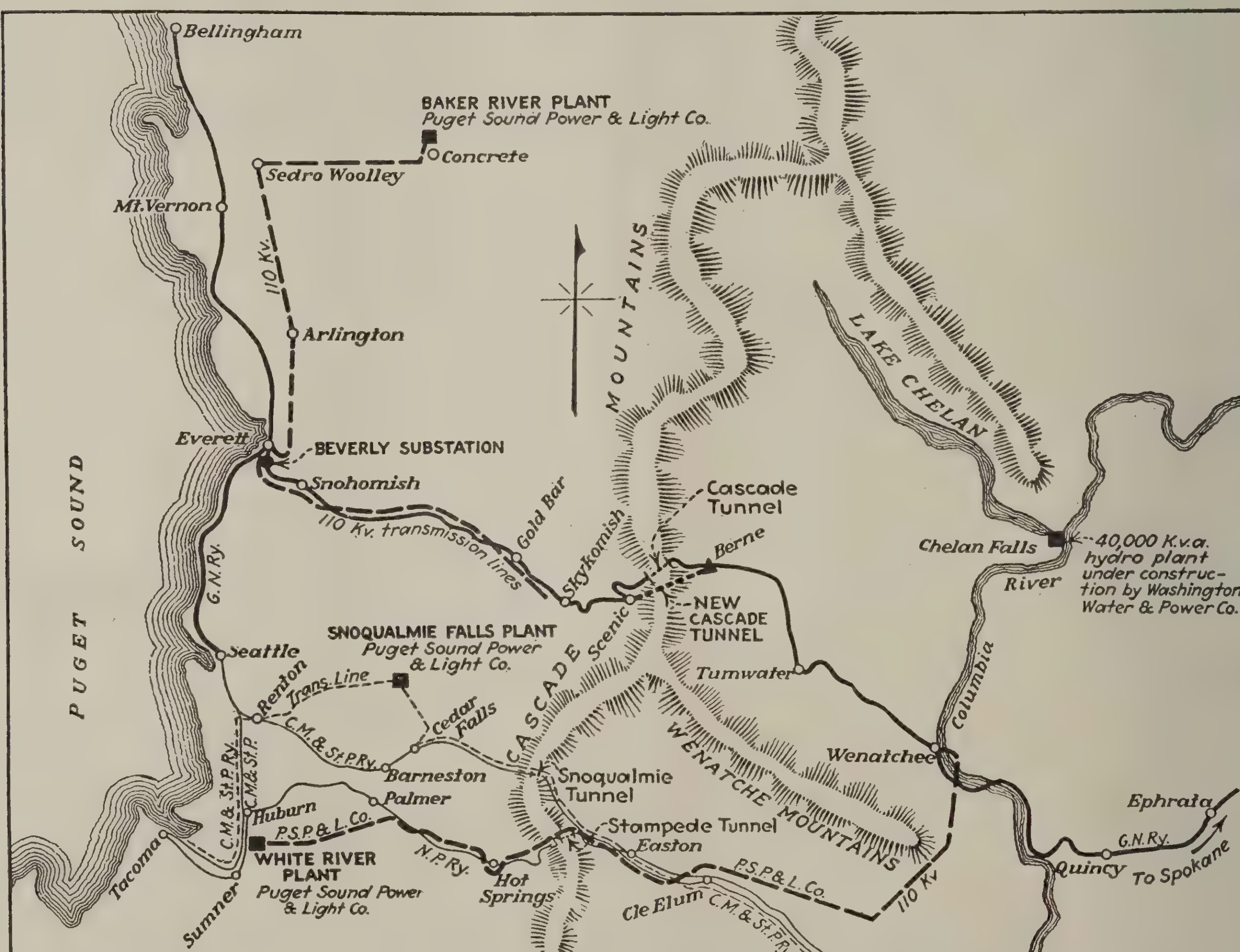
When the original installation was made there was no electric power supply within available distance from which power could be obtained. This necessitated the erection of a hydro-electric generating station at Tumwater on the Wenatchee River, a distance of 30 miles from the tunnel. Power produced here by two 2000-kw. three-phase, 25-cycle, 6600-volt units was transmitted to the substation at Cascade Tunnel at 33,000 volts. Water was brought to the plant, which operated under a head of 176 ft. in an 8½ ft. flume, two and one-half miles long.

The original electrification itself undoubtedly has served the purpose for which it was installed—the relief from an intolerable condition under steam operation. However, because of its special requirements of organization and operation, the electric service has been tolerated under extremely high operating costs.

Between Seattle and Skykomish, the profile shows that the grades are not unduly heavy, nor are the curvatures excessive, the heavy grades and curves being confined to that section on the west slope of the Cascade mountains, between Skykomish and Cascade tunnel and on the east slope between Cascade tunnel and Leavenworth. With conditions on the east slope the railway is not especially concerned at this time, as certain contemplated changes in line with other reasons, have for the present delayed the electrification of that side. On the west slope, however, a continuous grade of 2.2 per cent is encountered from Skykomish to Tye, a distance of 21.4 miles, with curvatures up to 10 deg., and from Tye to the summit of the range, through the Cascade tunnel, the grade is 1.7 per cent.

Steam Operation

A 2500-ton time freight, out of Seattle, or rather Interbay, the terminal yard, consisting of about 60 cars, covers the 80 miles to Skykomish in approximately 5½ hours when hauled by a 250-ton Mikado type 2-8-2 oil burning locomotive having a normal tractive power of 64,300 lb. At Skykomish two 2-6—8-0 Mallet type locomotives of 260 tons and developing a tractive effort of 78,300 lb. are cut into the train at about uniform distance apart, to assist on the 2.2 per cent grade to Tye. Including a delay at Skykomish for this operation of one hour and for water at Scenic of 20 minutes, the 21.4 miles to Tye is covered in 4½ hours. On arrival at Tye, the steam helpers are replaced by the electric loco-



Map of Everett-Wenatchee Section, Showing Location of New Tunnel and Power Lines That Will Furnish Energy for the Electrification

motives, located two ahead and two in the center of the train, and from Tye, the run to Cascade tunnel station is made in 22 minutes. Allowing 15 minutes at Cascade tunnel for cutting out the electrics and inspecting air brakes, the train when reassembled completes the remaining 53 miles to Wenatchee in four hours.

Reasons for Extending Electrification

After a thorough review of operation, the Great Northern management, realizing that considerable improvement could be made in the schedule and a substantial reduction in operating expenses, authorized electrification that would accomplish the desired results. This authorization provided for a new system of electrification as past experience dictated that extension of the original system was inadvisable.

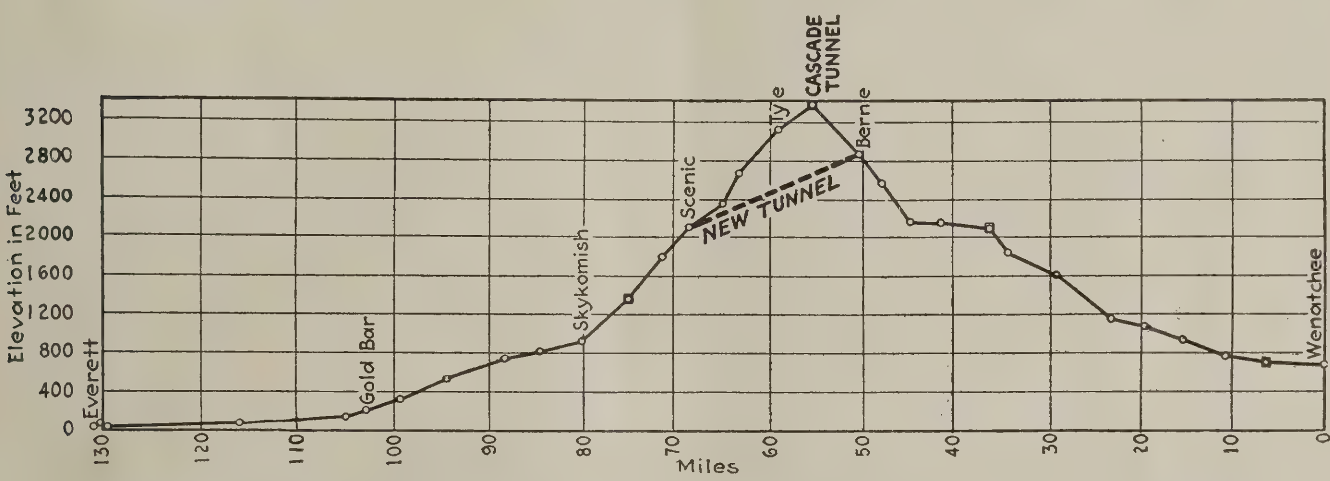
The experience, both favorable and unfavorable, gained from the original electrification was very helpful in selecting the new 11,000-volt, 25-cycle, single-phase system.

Some of the reasons for the use of 25 cycles on the new system as compared with the standard commercial frequency of 60 cycles are:

1. Facilitates use of full capacity of 6000-kw., 25-cycle output of Tumwater plant because of liberal design of three-phase machines which make possible full name-plate capacity at single-phase.
2. Some kind of rotating apparatus would have been required to convert single-phase railway load into balanced three-phase load on the power system supplying the energy.
3. Twenty-five cycles is standard for railway transformers and much other equipment which has been developed.
4. Less interference with communication circuits at 25 cycles.
5. Regulation of 25-cycle system is considerably better on fluctuating loads, and losses are less than on 60-cycle system.
6. Copper ground return because of higher impedance of rails would have been required for 60 cycles.

With the limitations contemplated in the power supply for the new electrification, it will be possible always to operate at practically an unlimited number of speeds up to the continuous rating of a locomotive because of the great flexibility of the motor-generator type unit. Furthermore, the method of accelerating a train by means of voltage control of the motor is ideal from the standpoint of economy, both in starting losses and in power demand from the sources of supply and by using a synchronous motor to drive the motor generator set on the locomotive, power-factor correction is obtained, making practically the entire output of the station useful power.

For regenerative-braking, the same flexibility of control is available as in motoring. It is possible to regenerate at all speeds within the established range of the locomotive, to practically standstill. The varied train weights over this section and the conformation of the country, make this wide range a very effective feature, as the speed, while regenerating, can be adjusted to suit the grade of any particular section.



Profile of Heavy Grade Section of the Great Northern Between Everett and Wenatchee in the State of Washington

Locomotives

The two new Baldwin-Westinghouse electric locomotives for the Great Northern each consist of two cabs which are identical, mechanically and electrically. Each one of these units is self-contained, that is, fully equipped to operate alone. Present plans are to operate two cabs as a road locomotive. Each locomotive weighs about 715,000 lb., is 94 ft. 4 in. long and has a continuous rating of 88,500 lb. tractive force 15.5 m.p.h. Maximum allowable speed is 37.5 m.p.h. and maximum rating is almost 7000 hp.

These two unit locomotives are the most powerful of this type ever built. One of them has been shipped to the Great Northern at Skykomish and the other will be completed in December.

Power Supply

The Great Northern has contracted with the Pudget Sound Power & Light Company to supply all power for the electrification. Under the agreement the Tumwater generating plant will be operated by the power company and tied in with its system through a 44-kv. railway transmission line at present and later possibly by its 110-kv. transmission line going via another route over the mountains to Wenatchee.

The present project involved the construction of a 110-kv. three-phase, 60-cycle transmission line from the Beverly substation of the power company, near Everett,

Washington to Skykomish; the erection of two new outdoor substations at Scenic and Cascade, respectively, a frequency changer set will also be installed in the Skykomish station where connection is made with the 110-kv. transmission line of the power company and the 44-kv. railway transmission line, which is also being erected at this time from Skykomish to Tumwater.

The two 44-kv. railway transmission lines, the trolley construction and signal line will all be carried on single poles along the right-of-way. The trolley contact line is No. 4/0 cadmium bronze supported by inclined catenary type of construction.

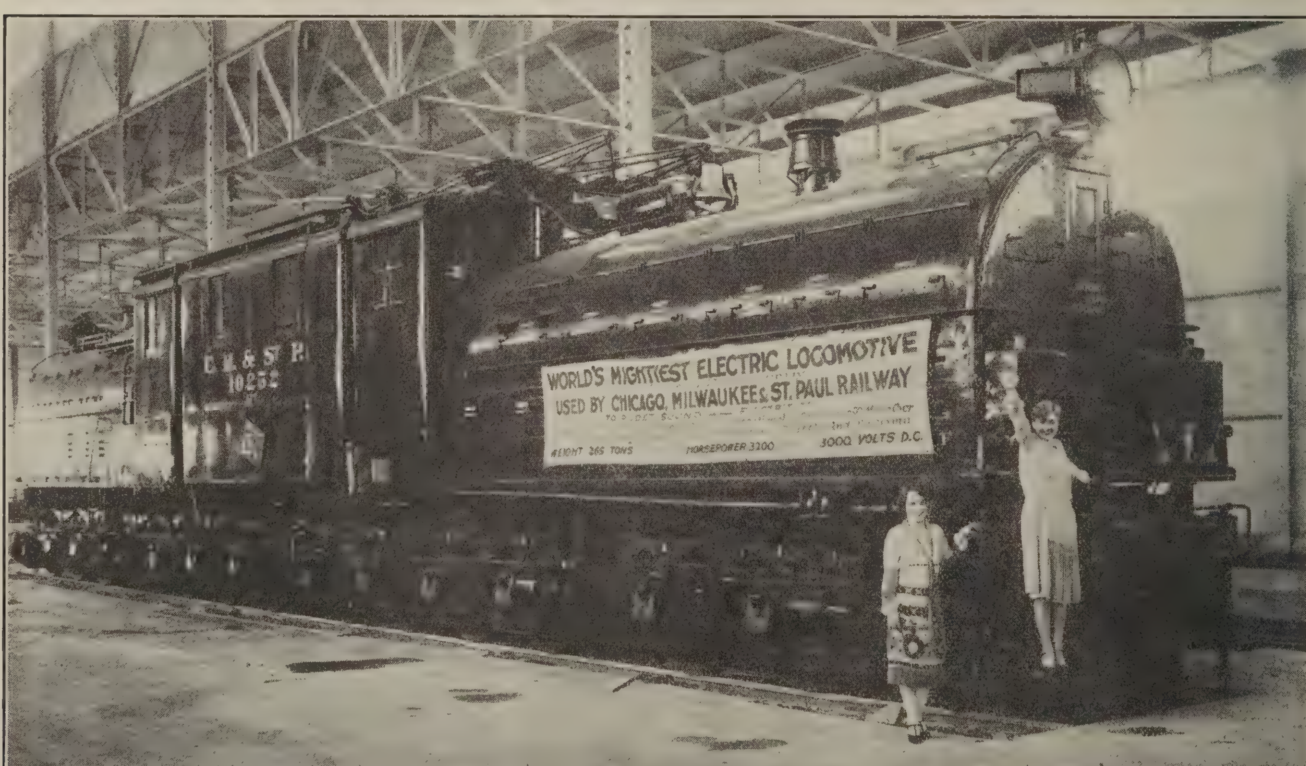
Careful consideration has been given to possible interference to signal and communication lines due to the single-phase system. The d-c. signal system will be changed to a-c. 60-cycles with 6600-volt transmission. Telegraph and telephone lines en route will undergo general revamping, using necessary cables or removing them from the right-of-way entirely. Local telephone lines heretofore adjacent to the right-of-way will be removed to a convenient distance therefrom to avoid inductive troubles. Distance as the most effective remedy has been the general basis on which the problem of inductive interference has been considered.

Metering presented some interesting problems to the power company owing to the condition of the contract which calls for the simultaneous measurement of demand at two widely separated points. In addition, it is necessary to take into account power fed back into the power company's system by the Tumwater plant and by the electric locomotives when regenerating. Power will be measured by two three-phase ratchet meters at each point and demands will be measured by graphic meters to obtain simultaneous records at the two points.

According to the contract billing for power will be made on the basis of the average of the three highest five-minute demands during the month. In the event of power failure any peaks occurring during the first fifteen minutes after service is restored are to be ignored. As all power taken by the railway company from the 110-kv. line of the power company will first pass through the frequency changers, driven by synchronous motors, it will be possible to maintain unity power factor or even a leading power factor if desired.

Simultaneously, with the rehabilitation and extension of the original electric section, a new tunnel through the Cascade Mountains was begun, and when completed this will be the longest railway tunnel in America—seven and three-quarter miles. The present line crosses the divide at an elevation of 3385 ft. above sea level. It has sharp grades and curves, numerous snow sheds and several tunnels one of which is the Cascade, 13,873 ft. long. On account of heavy snow fall, which reaches a maximum of 410 inches at one point and 670 inches at the Cascade Tunnel each season, it is difficult and expensive to keep the line open for operation. Increasing importance of a thoroughly dependable line, the necessity for additional snow sheds on the present route and the heavy repairs on the existing snow sheds brought expenditures to a point where a new line on a lower level would show a substantial gain.

The new tunnel line will shorten the right-of-way more than 7½ miles, eliminate nearly six complete circles of curvature and will escape most of the severe snow trouble. The grade will be the same as the present tunnel, but the elevation will be 500 feet lower. Electric power is being used throughout in its construction which it is expected will be completed in about two years.



C. M. & St. P. Electric Locomotive on Exhibition at the Sesqui-centennial Exhibition, Philadelphia

Changing Motors from Two to Three Phase Service

Showing the Methods of Deriving the Formulas Involved in Making Changes in Stator Windings

By Chas. R. Sugg
Electrical Engineer, Atlantic Coast Line

WITHIN the last two or three years the writer has found it necessary to rewind or reconnect a number of two phase motors for three phase service. Not being satisfied to use the "Tee" or Scott connection by cutting out coils because it is seldom that a balanced winding can be obtained, he made a study of the subject and devised the method explained in this article for reconnecting by using all coils and obtaining a balanced three phase winding.

As it was necessary to rewind a number of the motors, the method outlined herein of calculating the new winding was applied. This method does not require a knowledge of any of the characteristics of the material used in the manufacture of the motor but assumes the original motor and winding as 100 per cent and uses this as a basis for deductions.

By far the largest number of motors which find their way into repair shops only require that the mechanic have sufficient knowledge to remove the old coils and insulation and replace them with new. This requires only that the mechanic be accurate in his count and making of sketches, careful and neat in his work. Occasionally, however, most any repair shop will have motors sent to it which will require a change in the winding, such as being wound for different voltage, phase or speed.

Standard motors can usually be provided with windings of different characteristics, though at times the changes may be difficult if not impossible. In some cases special windings may be designed which satisfy the condition when standard windings could not be used.

Designing a winding for a motor when the original winding is known, does not require the use of very many equations. Usually a careful study and application of the equation:

$$E = \frac{4.44\ NTn}{10^8} \qquad \text{(A)}$$

(which we may call the fundamental equation) with a little modification will be found all that is required. The modifications usually required is the use of two additional quantities, the factors of distribution and chording, which for a given winding will be constant. Incorporating these coefficients in the above equation we have:

$$E = \frac{4.44\ NTn\,k'k''}{10^8} \qquad \text{(B)}$$

in which

	E	Impressed phase voltage
	N	Total Magnetic flux flowing from one pole
	T	Total number of turns connected in series
	n	Frequency of current
	k′	Factor of distribution
		.905 for complete 2 phase distribution
		.955 for complete 3 phase distribution
	k″	Factor for chording
		Sine of half the angle spanned by one coil
		$\text{Sin}\ \frac{\infty}{2}$
where α	=	Electrical angle spanned by one coil

If we write equation (B) thus

$$E_o = \frac{4.44\ N_oT_on_ok_o'k_o''}{10^8} \qquad \text{(B}_1\text{)}$$

to represent the original winding, and

$$E_f = \frac{4.44\ N_fT_fn_fk_f'k_f''}{10^8} \qquad \text{(B}_2\text{)}$$

to represent the final or desired winding and divide (B_1) by (B_2) we have after cancelling the constants 4.44 and $\frac{}{10^8}$.

$$\frac{E_o}{E_f} = \frac{N_oT_on_ok_o'k_o''}{N_fT_fn_fk_f'k_f''} \qquad \text{(C)}$$

If a given motor is to be rewound for change in voltage only, $N_o = N_f$, $n_o = n_f$ and $k_o' = k_f'$, and these qualities will cancel from the equation leaving

$$\frac{E_o}{E_f} = \frac{T_ok_o''}{T_fk_f''} \qquad \text{(D)}$$

and if it be decided to use the same chording, $k_o'' = k_f''$, and these quantities will also cancel out, leaving

$$\frac{E_o}{E_f} = \frac{T_o}{T_f} \text{ (E) or } T_f = \frac{E_fT_o}{E_o} \qquad \text{(E}_1\text{)}$$

giving the total number of turns in series. The number of turns per coil will depend upon whether the winding is to have one, two, three or "n" circuits in parallel. In any case, however, the total number of turns in series will be as indicated by the equation (E_1).

The size of wire will have to be varied in accordance with the current to be carried and if E_f is greater than E_o the current will be less and the size of wire reduced accordingly, and vice versa. The size of wire will also vary with the number of circuits connected in parallel, that is, a two circuit winding will require wire only one half the cross section in circular mils per circuit, that a one circuit winding will require.

Change in speed of a given motor will be accompanied by a proportionate change in power output, and before making any change in the winding, the power required should be ascertained to prevent liability of burn-out. Should, however, it be desired to rewind a stator for different speed but without change in frequency or phase, by using equation (C) and cancelling the quantities which are equal, viz.: $E_o = E_f$, $n_o = n_f$ and $k_o' = k_f'$, we have

$$1 = \frac{N_oT_ok_o''}{N_fT_fk_f''} \qquad \text{(F)}$$

$$\text{or } T_f = \frac{N_oT_ok_o''}{N_fk_f''} \qquad \text{(F}_1\text{)}$$

and if we assume the same chording constant for both windings, the equation becomes

$$T_f = \frac{N_oT_o}{N_f} \qquad \text{(F}_2\text{)}$$

This equation as it stands does not contain the function of speed, but the value of N changes in-

versely with the number of poles, as the flux density per unit area of pole face must be kept fairly constant, and since the total pole face area in a given motor is a constant quantity, any change in the number of poles will produce a relative change in the area of each pole face, the relative change will be inversely proportional. The relation is expressed in the equation

$$\frac{N_o}{N_f} = \frac{P_f}{P_o} \qquad \text{(a)}$$

where P_o is the original number of poles and P_f is the final or desired number of poles.

Change in speed of induction motors is accomplished by changing the number of poles, the change being inversely proportional to the number of poles, and is expressed by the equation

$$\frac{R_o}{R_f} = \frac{P_f}{P_o} \qquad \text{(b)}$$

where R_o = R.P.M. with original winding and
R_f = R.P.M. with final or desired winding

Inspection of equations (a) and (b) shows that the right hand side of both equations is identical, and since things that are equal to the same thing are equal to each other, the left hand sides of the equations must be equal, as expressed by the equation

$$\frac{N_o}{N_f} = \frac{R_o}{R_f} \qquad \text{(c)}$$

By substituting the value of $\frac{N_o}{N_f}$ in equation (c) for that in equation (F_2) we have

$$T_f = \frac{R_o T_o}{R_f} \qquad (F_3)$$

this can also be expressed in terms of the number of poles as follows:

$$T_f = \frac{P_f T_o}{P_o} \qquad (F_4)$$

Both of these equations give the total turns in series between phase terminals. The size of wire must be determined as before mentioned, remembering that change in horsepower, and therefore current value, is approximately in proportion to change in speed.

Following the same method of eliminating like quantities from equation (C) we have for rewinding a given motor for change in frequency, the equation,

$$T_f = \frac{T_o n_o}{n_f} \qquad \text{(G)}$$

Inspection of equations (E_1), (F_4) and (G) shows that the repair man is primarily interested in knowing the total number of turns in series to obtain the proper operation. The equations mentioned assume the same chord factor, phase distribution factor, type of connection and phase. This limitation, however, is not necessary, for by using equation (C) and substituting the proper values for the various quantities, the winding can be changed from star to delta, from delta to star, from star to two-phase, from two-phase to star, from delta to two-phase, from two-phase to delta, from two-phase star to two-phase mesh or two-phase mesh to two-phase star. (Two-phase mesh is seldom used in standard motors and is mentioned here only as a possibility.) In changing from delta to star it must be remembered that the star phase winding voltage is 57.7 per cent of the phase winding voltage of the delta winding, and that the delta winding voltage is always the line voltage.

In proportioning the size of wire for the winding it must be remembered that the current in a star winding is always equal to the current in the line, and the current in a delta winding is 57.7 per cent of the current in the line.

The distribution factor k′ in equation (B) is the ratio of the length of the chord to the length of the arc of the theoretic electrical circle (lengths expressed in radians for convenience) over which the winding is distributed and for two-phase the arc is 90° or $\frac{\pi}{2}$ radians, and the chord is $\sqrt{2}$ radians, or

$$k' = \frac{\sqrt{2}}{\frac{\pi}{2}} = \frac{2\sqrt{2}}{\pi} = .905 \text{ approx.} \qquad \text{(H)}$$

For 3-phase distribution the arc is 60° or $\frac{\pi}{3}$ radians and the chord is 1 radian, making

$$k' = \frac{1}{\frac{\pi}{3}} = \frac{3}{\pi} = .955 \text{ approx.} \qquad \text{(I)}$$

These values are constant for complete distributed windings such as usually found in commercial motors.

The chord factor k″ in equation (B) is the ratio of length of the theoretic electric chord spanned by one coil to the diameter of the theoretic electrical circle

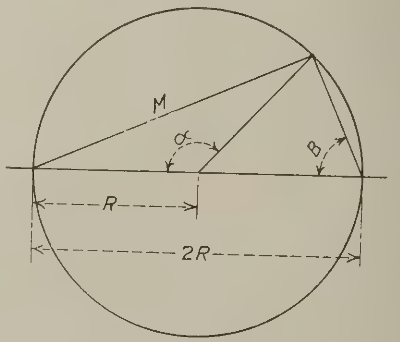


Fig. 1 Theoretical Electric Circle

expressed in radians. From the center of a North pole to the center of the adjacent South pole is 180 electrical degrees and from one North pole to the next North pole is 360 degrees. This is the theoretic electrical circle referred to above. The value of k″ can perhaps be best explained by trigonometric derivation.

The circle in Fig. 1 represents the theoretic electric circle and the radius R is taken as unity, M is the chord.

∝ is the angle spanned by one coil

From above definition

$$k'' = \frac{M}{2R} \qquad \text{(J)}$$

By inspection it is seen that

$$\beta = \frac{\alpha}{2}$$

$$\text{and } M = 2R \sin \beta$$

$$= 2R \sin \frac{\alpha}{2}$$

Substituting this value of M for M in equation (J) we have

$$k'' = \frac{2R \sin \frac{\alpha}{2}}{2R}$$

$$= \sin \frac{\alpha}{2} \qquad (J_1)$$

In which α is the electrical angle in degrees spanned by one coil. To determine the value of α divide 180 by the number of teeth enclosed by the full pitch and multiply by the number of teeth enclosed by the chorded pitch, that is, if full pitch winding is 1 and 13 the number of teeth included is 12, and if the chorded pitch is 1 and 11 the number of teeth is 10. In this case the value of α would be

$$\alpha = \frac{180 \times 10}{12}$$

$$= 150°$$

$$\text{and } \frac{\alpha}{2} = 75°$$

from the trigonometric table the sine of 75 degrees is .966 which would be the value of k″ in the equation.

Since the numerical values of k′ and k″ are always less than unity except for concentrated and full pitch windings, it is evident that it is necessary to add turns to compensate for voltage reactions in distributed and chorded windings. The rapid increase in number of added turns required to compensate for chording as the angle is reduced makes it necessary that this feature be limited, some writers advocate a limit of 90 degrees for α, but the writer would prefer to limit chording to 130 degrees. The value of k″ for α = 90 degrees is .707 and for $\alpha = 130°$ is .906. This shows that for α = 90 degrees approximately 40 per cent more turns must be added for compensation, while for α = 130 degrees only 11 per cent more are required.

The foregoing remarks apply specifically to rewinding stators of induction motors, assuming that the original winding is known. To design a winding for a given frame from which the original winding has been stripped and is not known involves a knowledge of several factors, such as leakage, hysteresis, heating coefficients, etc., which is beyond the scope of this paper. If, however, a repair shop should keep a complete record of all types and makes of motors repaired by them, together with dimensional data of the stator frame, tooth and slot dimensions and air gap, a fairly good average of the values of magnetic density in the air gap can be found for the various types and makes which can be used to advantage in designing windings. Some writers advocate a density of 20,000 lines per square inch of pole face, but the writer has found that pole face density varies considerably. Other writers advocate flux density in core behind the teeth to lie between 80,000 and 100,000 lines per square inch of core.

Equation **(C)** can be applied to the problem of reconnecting a given winding from 2-phase to 3-phase, 3-phase delta to 3-phase star, or 2-phase star to 2-phase mesh and vice versa.

In reconnecting a given winding without rewinding, using all the turns of the winding, the total number of turns in the motor is constant and the problem is to group them so that the voltage will be within a permissible working range of the line voltage.

Consider reconnecting a 3-phase delta motor for operation on 2-phase at the same voltage, horsepower, speed and frequency. Rewrite equation **(C)** as follows:

$$\frac{E_2}{E_d} = \frac{N_2 T_2 n_2 k_2' k_2''}{N_d T_d n_d k_d' k_d''} \qquad \textbf{(K)}$$

where the subscript 2 refers to the 2-phase connection and d to the 3-phase delta connection.

This equation is for single circuit windings only and to use it with multiple circuit windings we must modify it somewhat. Since the total number of turns in a given winding is constant the turns per phase is fixed and the number of turns per circuit will be equal to the number of turns per phase divided by the number of parallel circuits.

If T'_2 and T'_d in **(K)** be the total number of turns per phase in the two phase and three phase connections respectively, T_2 and T_d the number of turns in each parallel circuit and Q_2 and Q_d the number of parallel circuits, we have,

$$T_2 = \frac{T_2'}{Q_2} \qquad \textbf{(d)}$$

$$\text{and } T_d = \frac{T_d'}{Q_d} \qquad \textbf{(e)}$$

If T = the total number of turns on the motor

$$T_2' = \frac{T}{2} \text{ for 2-phase winding} \qquad \textbf{(f)}$$

$$\text{and } T' = \frac{T}{3} \text{ for 3-phase winding} \qquad \textbf{(g)}$$

Substituting value of T_2 and T_d in **(d)** and **(e)** in equation **(K)** we have

$$\frac{E_2}{E_d} = \frac{N_2 T_2' Q_d n_2 k_2' k_2''}{N_d T_d' Q_2 n_d k_d' k_d''} \qquad \textbf{(K}_1\textbf{)}$$

Since the speed and frequency is not to be changed the number of poles will remain the same $N_2 = N_d$, $n_2 = n_d$ and $k_2'' = k_d''$ and will cancel from the equation leaving

$$\frac{E_2}{E_d} = \frac{T_2' Q_d k_2'}{T_d Q_2 k_d'} \qquad \textbf{(K}_2\textbf{)}$$

Dividing equation **(f)** by **(g)**

$$\frac{T_2'}{T_d'} = \frac{3T}{2T} = \frac{3}{2} \qquad \textbf{(K)}$$

and substituting this value of $\frac{T_2'}{T_d'}$ for that in **(K₂)** we have

$$\frac{E_2}{E_d} = \frac{3 Q_d k_2'}{2 Q_2 k_d'} \qquad \textbf{(K}_3\textbf{)}$$

$$\text{or } E_2 = \frac{3 E_d Q_d k_2'}{2 Q_2 k_d'} \qquad \textbf{(K}_4\textbf{)}$$

Substituting values of k_2' and k_d' in **(H)** and **(I)** in **(K₄)** and reducing we have

$$E_2 = \frac{3 E_d Q_d \frac{2\sqrt{2}}{\pi}}{2 Q_2 \frac{3}{\pi}}$$

$$= \frac{E_d Q_d \sqrt{2}}{Q_2} \qquad (K_5)$$

$$\text{or } Q_2 = \frac{E_d Q_d \sqrt{2}}{E_2} \qquad (K_6)$$

which are the equations for changing from 3-phase delta to 2-phase star and vice versa.

By a similar analysis of equation **(K)** the relation between E_d and E_y is found to be

$$E_d = \frac{E_y Q_y \sqrt{3}}{3Q_d} \qquad (K_7)$$

$$\text{and } Q_d = \frac{E_y Q_y \sqrt{3}}{3E_d} \qquad (K_8)$$

or vice versa

By equating the values of E_d Q_d in equations **(K_5)** and **(K_7)** and solving for E_2 we have

$$E_2 = \frac{E_y Q_y \sqrt{2}\sqrt{3}}{3Q_2} = \frac{E_y Q_y \sqrt{6}}{3Q_2} \qquad (K_9)$$

(K_7) is the equation for changing from 3-phase star to 3-phase delta and **(K_9)** for changing from 3-phase star to 2-phase star.

Further analysis of equation **(K)** with subscripts changed to represent the 2-phase star and 2-phase mesh windings the relation between E_2 and E_m (where E_m represents the 2-phase mesh voltage) is found to be,

$$E_2 = \frac{E_m Q_m \sqrt{2}}{Q_2} \qquad (K_{10})$$

which is the equation for changing from 2-phase mesh to 2-phase star and vice versa.

Equating **(K_9)** and **(K_{10})** and solving for E_y

$$E_y = \frac{E_m Q_m \sqrt{3}}{Q_y} \qquad (K_{11})$$

Equating **(K_5)** and **(K_{10})** we have

$$E_d = \frac{E_m Q_m}{Q_d} \qquad (K_{12})$$

which is the equation for changing from 2-phase mesh to 3-phase delta and vice versa.

Equations **(K_5)**, **(K_7)**, **(K_9)**, **(K_{10})**, **(K_{11})** and **(K_{12})** express relations which can be obtained by standard

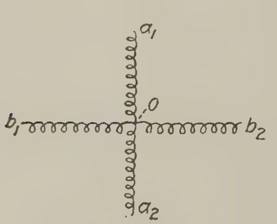


Fig. 2 Two-Phase Star

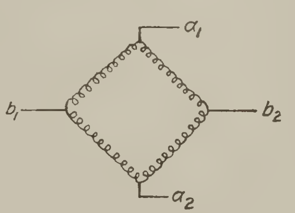


Fig. 3 Two-Phase Mesh

connections, and table (1) gives the relations in per cent of the voltage of the original winding, as determined by the above equations.

To change from 2-phase star to a 2-phase mesh, disconnect both windings at O Fig. 2, and connect a_1O to b_1, b_1O to a_2, a_2O to b_2 and b_2O to a_1 as shown in Fig. 3.

Inspection of table 1 shows that it is not possible to reconnect many motors for different phase operation by using standard connection diagrams without leaving out part of the original coils. It is sometimes possible to use a special connection diagram and get within satisfactory operating voltage range of the voltage desired. Take for instance a 100 volt 2-phase, 4-pole motor with 48 slots and 48 coils connected single circuit to be reconnected for operating on a 3-phase circuit of the same voltage and frequency as the 2-phase circuit. Reference to the table will show that if star connected it will require 123 volts on the 3-phase line for proper operation. If connected delta it will only require 71 volts. Both of these voltages are outside of the permissible working range which is 10 per cent over or under the name plate rating. If, however, we group the winding for 3-phase connection and instead of connecting for either star or delta but connect it up into a star—delta connection Fig. 4 by connecting one end of phase "a," which would ordinarily be connected to the common point in a star winding, to the middle of phase "b" as in Fig. 5 or to the middle of phase "c" as in Fig. 6, or

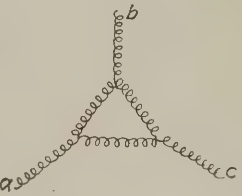


Fig. 4

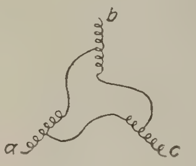


Fig. 5

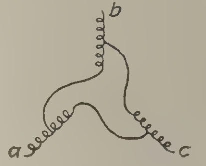


Fig. 6

connect phases "b" and "c" in the same manner as shown in Fig. 5 and Fig. 6, being careful to get the right end of each phase connected to the middle of the adjacent phase, the winding can be connected so as to be within 10 percent of the operating voltage for now we have connected half of the winding in delta and half in star. By referring to table 1 we will note that to connect the motor single circuit star will give 123 volts and single circuit delta 71 volts. Now as we have connected only half of the winding in delta, that part of the winding will be good for 35.5 volts, and since only half of the winding is connected star, that part will be good for half of 123 or 61 volts, and if we add 35.55 to 61 we have 96.5 volts which is the voltage that the motor will operate on satisfactorily. This, it is noted, is only 3½ percent under the normal operating voltage and is well within the 10 percent range.

This connection should be made between pole groups and never tapped within a pole group. For instance a two circuit six pole motor will have three pole groups in series and the middle point is in the middle of one pole group. This need not worry us, however, for we can connect one pole group in delta and the two remaining pole groups as the star leg of the winding, which will give 105 as the proper voltage; this is well within the permissible range, and can be operated satisfactorily.

Since the current in a 3-phase circuit is greater than that in a 2-phase circuit by approximately 22 percent we cannot operate a motor, which is connected wholly or in part in star, at the same horsepower output and temperature rating, so the above motor will have an output about 20 percent less than original rating at 2-phase. If the motor is an old 40 degree motor, the rating can be changed to 50 degree rating and the output rating will be approximately 96 percent of the original 2-phase rating.

Sometimes it might be possible to reconnect 3-phase motors for 2-phase operation by using a combination of the 2-phase star and 2-phase mesh windings, but usually it is not safe to use the mesh connection unless

it is known that the two-phase circuit is not interconnected in any way. For instance, the writer knows of a case where autotransformers are used on a 2-phase circuit to step the current down for rotary converters. This connection interconnects the phases through the rotary and unbalances the voltage between phases very badly.

It is sometimes desired to reconnect a motor for a different frequency than that for which originally wound. Whether this can be done in a given motor or not may be ascertained from the equation,

$$\frac{E_o}{E_f} = \frac{N_o T_o' Q_f n_o k_o' k_o''}{N_f T_f' Q_o n_f k_f' k_f''} \qquad (P)$$

where the subscripts o and f denote original and final or desired values, and the letters represent the same quantities as in equation **(K_1)**. It must be noted that T_o' and T_f' represents the total number of turns **per phase** in the original and final connections instead of the number of turns in series per circuit. The number of turns in series per circuit for the reconnected winding is expressed by the equation,

$$T_f = \frac{T_f'}{Q_f} \qquad (i)$$

This is the quantity that the winder first requires and he can then determine the number of circuits if he finds that the grouping is possible.

Solving **(P)** for $\frac{T_f'}{Q_f}$ we have

$$\frac{T_f'}{Q_f} = \frac{E_f N_o T_o' n_o k_o' k_o''}{E_o N_f Q_o n_f k_f' k_f''} \qquad (P_1)$$

$$\text{or } T_f = \frac{E_f N_o T_o' n_o k_o' k_o''}{E_o N_f Q_o n_f k_f' k_f''} \qquad (P_2)$$

By being careful to substitute the proper numerical values for all quantities in the right side of **(P_2)** the total number of turns in series per circuit per phase can be found for any frequency desired and dividing the total number of turns per phase by this quantity will give the number of parallel circuits in which the winding must be divided and unless this is sufficiently close to a whole number to make the voltage within ten per cent of the line voltage the change cannot be made without rewinding, unless further inspection would indicate that a composite star-delta or star-mesh winding can be arranged.

Sometimes it may be desired to reconnect a given motor for change in speed. In an induction motor the speed varies inversely with the number of poles. Change in speed will also cause a corresponding change in counter e.m.f. which will in turn necessitate a corresponding change in line voltage. Since the line voltage is fixed it will be necessary to arrange the grouping of the coils so as to obtain a voltage value which will be within the permissible operating range of the line voltage.

By substituting the proper numerical values in **(P_2)** and cancelling all like quantities the required value of T_f can be found, which if divided into the total number of turns per phase it will be found whether or not the winding can be reconnected without rewinding in the same manner as for change in frequency.

Orig. Con.			Phase	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
Phase	#Circuits	Connect	Circuits	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
			Connection	Y	Y	Y	Y	Δ	Δ	Δ	Δ	+	+	+	+	◇	◇	◇	◇
3	1	Y	Figures to right show per cent voltage obtained by changing connections from the original connections at the left to the connections indicated at the top.	100	50	33	25	58	29	19	14	82	41	27	20	58	29	19	14
3	2	Y		200	100	67	50	115	58	38	29	163	82	54	41	115	58	39	29
3	3	Y		300	150	100	75	173	87	58	43	245	122	82	61	173	87	58	43
3	4	Y		400	200	133	100	231	115	77	58	326	163	109	82	231	115	77	58
3	1	Δ		173	87	58	43	100	50	33	25	141	71	47	35	100	50	33	25
3	2	Δ		346	173	115	87	200	100	67	50	283	141	94	71	200	100	67	50
3	3	Δ		519	260	173	130	300	150	100	75	423	212	141	106	300	150	100	75
3	4	Δ		693	346	231	173	400	200	133	100	566	283	188	141	400	200	133	100
2	1	+		123	61	41	31	71	35	24	18	100	50	33	25	71	35	24	18
2	2	+		245	123	82	61	141	71	47	35	200	100	67	50	141	71	47	35
2	3	+		367	184	123	92	212	106	71	53	300	150	100	75	212	106	71	53
2	4	+		489	245	163	123	283	141	96	71	400	200	133	100	283	141	96	71
2	1	◇		173	87	58	43	100	50	33	25	141	71	47	35	100	50	33	25
2	2	◇		346	173	115	87	200	100	67	50	283	141	94	71	200	100	67	50
2	3	◇		519	260	173	130	300	150	100	75	423	212	141	106	300	150	100	75
2	4	◇		693	346	231	173	400	200	133	100	566	283	188	141	400	200	133	100

Table 1

Table showing voltage relations for connection changes of Polyphase motor stator windings using all coils. Frequency and speed remaining the same

In all of the above equations reference has been made to the number of **turns** in the winding. In a given winding in a stator it is, however, practically impossible to determine the number of turns, but since the number of turns per coil is the same, the number of turns is proportional to the number of coils and the number of coils can be substituted in all equations from **(K)** to **(P_2)** inclusive where turns are indicated.

In every case, whether rewinding or reconnecting, the winder must determine whether or not he can rearrange the grouping for a balanced winding. It is always preferable to have coils equally grouped if possible. If the motor is to be rewound for 3-phase, the total number of slots divided by 3 times the number of poles should be a whole number, and if it be rewound for 2-phase if divided by twice the number poles the quotient should be a whole number, though this is not always necessary provided each phase has the same number of turns or coils in series per circuit and allowance be made for the difference in the number of coils per pole group. It may be generally stated that if the number of slots per pole is divisible by 6 (which is the least common multiple of 2 and 3)

either a 2-phase or 3-phase winding may be applied, otherwise an unbalanced winding may be expected with either the 2-phase or the 3-phase winding or both.

In rewinding or reconnecting a motor it must be understood that physical conditions, such as, slot dimensions, speed limitations, balancing of the windings on account of inability to distribute the windings between the phases, carrying capacity of the conductors, etc., may prevent the changes desired even though equations herein stated may indicate that the change can be effected. It is therefore well to determine whether the physical conditions can be satisfied by the change before applying these formulae.

Car Lighting Generators of Reduced Weight

Safety Company Adopts Drawn Steel Electrically Welded Generator Magnet Frames

THE magnet frames of car lighting generators manufactured by the Safety Car Heating & Lighting Company, are now being made of drawn steel. This change in construction reduces the weight of machines including the supporting lug and pulley approximately 10 per cent.

Previously all frames were made of cast steel, and the type B cast steel machine complete with pulley weighs 511 lb. as compared with 465 lb. for the same machine with a drawn steel frame. The type C machine with cast steel frame complete with pulley weighs 646 lb. and with drawn steel frame weighs 598 lb.

The reduction of weight will be an aid to reduction of dead weight of cars and will make it a little easier to handle generators in the shop and it is also expected to show an increase in belt life. Coupling shocks cause generators to swing against the belt and strain fasteners

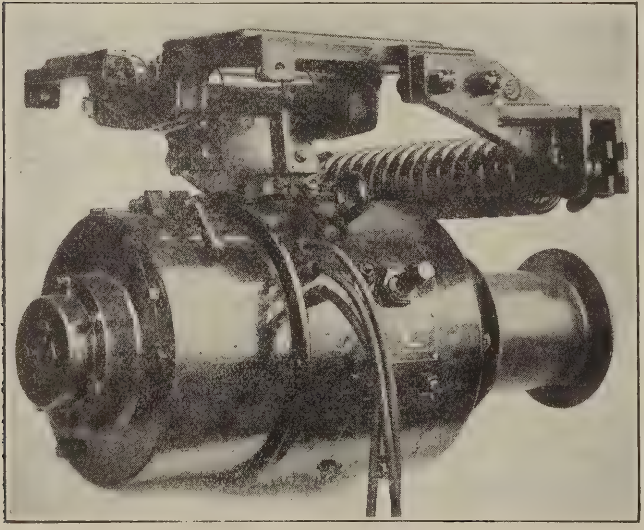


Fig. 1. A Drawn Steel Frame Car Lighting Generator Complete With Suspension and Belt Tension Device

so that the belt is lost later on the road. As these strains are proportional to the inertia of the generator, the fifty-pound reduction of weight should aid in reducing them.

Magnet Frame Construction

The drawn steel frames are made up of three parts, namely, the pulley end housing, the commutator end housing and the center part, approximately one inch thick, which forms the field yoke. The three parts which are formed in this manner are illustrated in Fig. 2.

The center portion or field yoke is made by rolling into circular form a flat slab of steel of the proper magnetic quality. After this has been rolled into the form of a cylinder, the ends are united along an element of the cylinder by electric arc welding. The cylinder

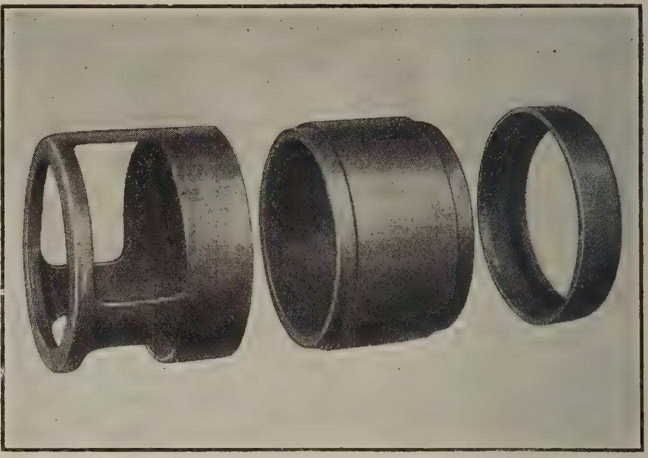


Fig. 2. The Three Principle Parts of a Drawn-Steel Generator Frame. The Reinforcing Rings Have Been Spot Welded into the End Housings

is then worked by a die to bring it into perfect cylindrical form.

The end housings are drawn from 9/32-in. steel into the necessary cup form and the openings for the heads and the inspection holes are sheared out in large presses.

The field yoke is machined as shown in Fig. 2 so that the end housing will go over the end of the ring with a force fit and up against the shoulder formed by the machine, after which they are welded into place. The position of these welds may be seen in Fig. 4 and Fig. 5.

In both of the end housings, a continuous steel ring is spot welded in place serving to take the tappings for the head bolts. The head rings are shown in Fig. 5 as R and R^1.

After the frame has been made as described, it is necessary to machine it to get the correct diameter for the application of the poles and for the head fits. It is also necessary to machine the ends slightly in order to get the overall length correct. The operation of machining the commutator end for head fit is shown in Fig. 6.

After the frame has been machined to size it is drilled and tapped for eye bolts, pry stud, name plate and sup-

porting lug bolts, but rings and studs are not applied until it is known whether machine is to be mounted right or left handed. Terminal block or lead outlet housings if used are riveted to the frame and welded around the edges to make them water tight.

Suspension

The generator suspension remains essentially unchanged except for the supporting lug. The lug instead

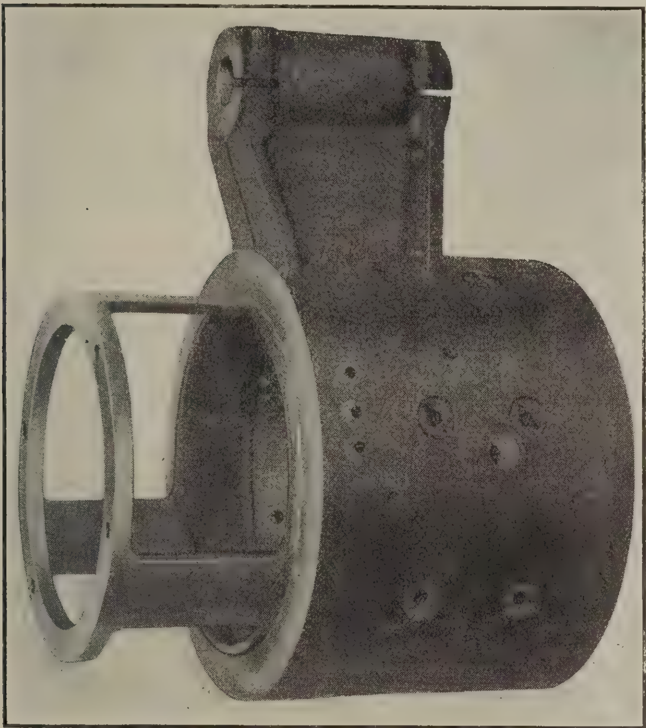


Fig. 3. A Cast Steel Magnet Frame

of being cast as a part of the frame is now made of three pieces of pressed steel formed and assembled as shown in Fig. 7.

The main or central part of the lug is secured to the generator frame by eight 9/16-in. bolts made of special steel, S. A. E. specification No. 1030. The bolts are

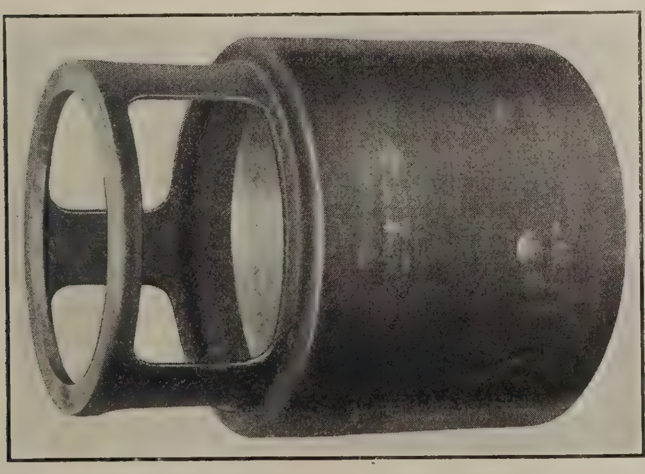


Fig. 4. A Drawn Steel Magnet Frame

riveted over on the outside. This center part of the lug is bent so as to form a safety strap over the suspension shaft, but the opening in the strap is larger than the shaft so that the shaft and strap are not normally in contact with each other.

The two end straps which form part of the lug are

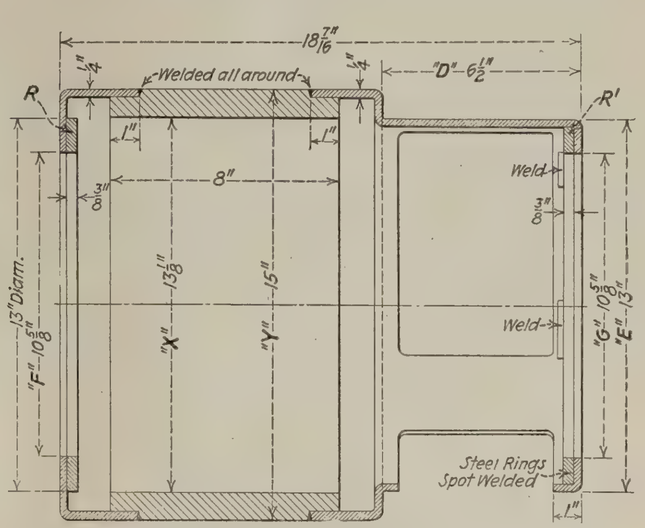


Fig. 5. Cross Section of a Drawn Steel Magnet Frame

each bolted to the central part of the lug by two ¾-in. bolts. The suspension shaft is clamped tightly by the two end straps. The ends of the suspension shaft are

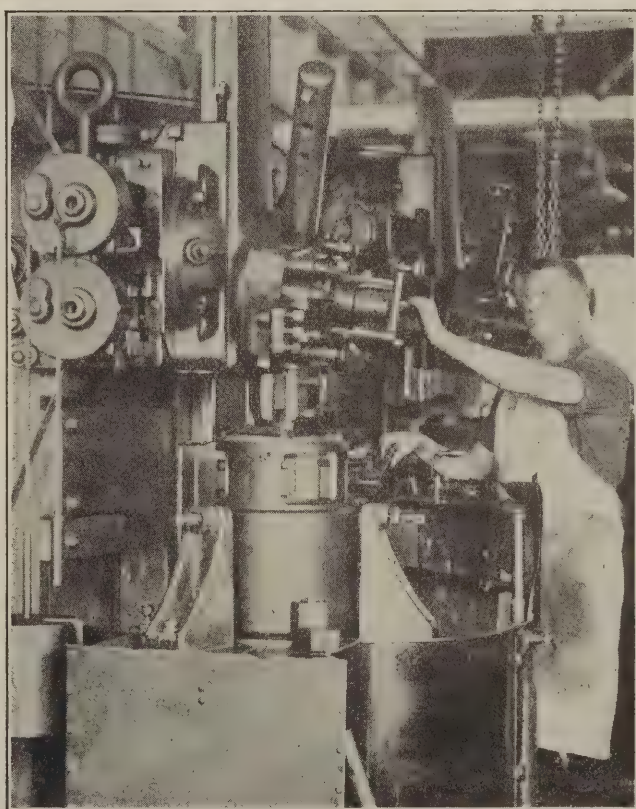


Fig. 6. Machining the Commutator End Housing for Head Fit

carried in bronze bearings and these bearings are supported by the suspension frame as shown in Fig. 7 and Fig. 1. The bearing bushing is provided with grease grooves extending around the inside surface of the bushing, the grooves being open at the end of the bushing. Grease is introduced into these grooves either from a compression grease cup or a grease gun, and the grooves

on the inner surface of the bushing feed the lubricant to the bearing surfaces.

Belt Tension Devices

The two standard Safety methods of obtaining belt tension will be retained. One of these is shown in Fig. 1, and consists of a tension spring connected at one end of the suspension frame and at the other end to a lug on the generator frame. If the belt is shortened, more of the generator weight will hang in the belt and the tension on the spring will also be increased slightly. However, as the generator swings forward on the shortened belt, the lug is raised so that the lever arm through which the spring operates is shortened and the actual tension on the belt caused by the spring is lessened. The increased tension caused by generator weight is thus offset by decreased spring action and the actual belt tension is approximately constant for any practical position of the generator.

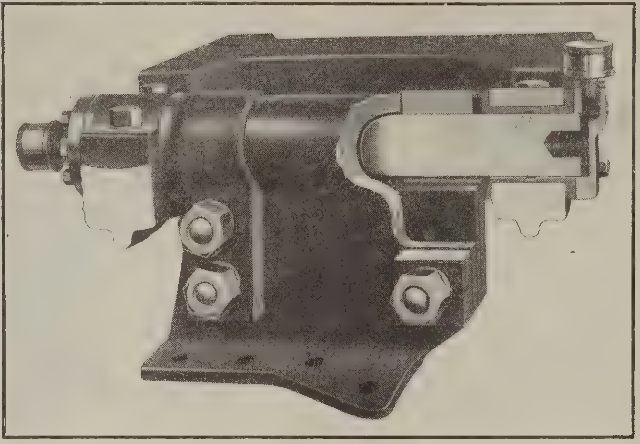


Fig. 7. Supporting Lug, Shaft and Bearing with Section Cut Away to Show Construction

The other tension device, not illustrated, consists of a compression spring connected at one end to a lug on the generator and on the other end to a lug mounted on the car underframe. The same principle for obtaining constant belt tention is used in both cases. The compression spring is ordinarilly employed when it is desired to have the center line of the pulleys on the center line of the car.

Interchangeability

All of the Safety features of interchangeability of parts have been retained so that with three drawn steel frames and six armatures it is possible to have machines of six different capacities varying from 1 to 4 kw. The distance from the center line of the car to the center line of the pulley is the same on all machines, so that a small machine can be replaced by a larger one without changing the axle pulley or the suspension frame. The dimensions "X" and "Y," Fig. 5, are different for the three different frames.

The dimensions "D" and "E," Fig. 5, are constant for all frames so that one band hole cover will fit all machines. Dimensions "F" and "G" are the same for all frames and thus one pair of heads will fit all machines providing a smaller bearing is not used with the small size or 13-in. frame. One shaft will also fit all machines if smaller bearings are not used and one size bearing can be used for all machines. Similarly one type of brush and one brush rigging will fit all machines. Electrical characteristics have not been changed.

During the month of October, 1926, 445 commercial vessels and 19 small launches passed through the Panama Canal. The daily average number of transits of seagoing vessels for the month was 14.36, and the daily average tolls collection $64,168. Although collections during the month were less than during the two preceding months, the monthly average for the first 10 months of the present calendar year is slightly in excess of $2.000,000.

Erie Suburban Train at Hawthorne, N. J.

A Modern Brick Building Houses the Battery and Yard Electricians Repair Rooms

Northern Pacific Coach Yard Facilities

Purchased Power Distributed in Parkway Cable Supplies the Entire Layout—Ample Lighting in Yard and Buildings

A DISTINCT innovation in passenger coach yards is a justifiable claim that can be made respecting the new passenger equipment terminal facilities completed recently by the Northern Pacific at St. Paul, Minn. Instead of the usual dismal, ramshackle appearance due to a disorderly arrangement of materials and buildings common in many yards of this nature, the visitor is greeted by a group of attractive brick buildings, well lighted, adjoining a yard containing 6½ miles of track, the entire project, including a commissary, yard office, Pullman building, storehouse, power plant, ice house and battery building, occupying about 15 acres of reclaimed land near the Mississippi river and within a half mile of the St. Paul Union station.

The power house is distinctive for the advanced character of its construction and equipment, the boilers being equipped with mechanical underfeed stokers, steam driven induced draft fans, feed water regulators, soot blowers, etc. A steam jet ash conveyor is also included. This power plant which has three 84 in. by 18 ft. horizontally return tubular boilers rated at 180 lb. pressure and 200 b. hp. capable of carrying 200 per cent load, furnishes steam for heating the various buildings in the coach yard and the coaches, as well as compressed air for the shop buildings and yard. Steam and air are also supplied to the Soo line coach yard which adjoins this new yard, resulting in a saving to both railroads by virtue of the greater economies possible in furnishing this service from a single power plant. To indicate and record this steam and air service properly to the Soo line yard, two Republic graphic flow meters and two Republic flow integrators are installed, one in each service connection. The metering dials, operated electrically, are mounted in the compressor room of the boiler house alongside of the main control gages. The air compressor is a Worthington Uniflow steam engine driven unit with a capacity of 800 cu. ft. per minute.

The engine room is floored with red tile and has a wainscoating of tan colored, enameled brick, all above which is painted battleship gray. This gives a very neat and pleasing appearance.

Electrical Energy Is Purchased

A 3-phase transformer bank, 2,300/230-volt, 37½ kva. each, is mounted on a platform outside the boiler house, this being the service connection with the Northern States Power Company, which furnishes all the electrical energy consumed in the coach yard and commissary.

To control this service a five panel switchboard, which was designed by the railroad and built by the Westinghouse Company, is mounted in one corner of the engine room of the boiler plant. Three of these panels are for alternating current and two for direct current service. A watthour maximum demand meter with a 15 min. time interval and 3-pole, 400 amp. main entrance switch are mounted on one panel. There are eight 3-pole knife switches, four to a panel, for a-c. distribution of power and light. For control of the motor-generator set which is in the same room of the boiler house, a panel has been provided mounting a (0-150) voltmeter and (0-400) ammeter, two ground detector lamps, a voltmeter switch, an ammeter switch, a generator field rheostat and a double-pole knife switch for the d-c. side of the generator. Adjoining this panel is another equipped with three Westinghouse 200-amp. Type-CL overload and reverse current circuit breakers, one for the battery building charging circuit and two for yard charging circuits. On sub-panels near the floor are two polyphase watthour meters, one recording energy used by the dining car department, the other one recording that used for train lighting. All switchboard meters are Westinghouse instruments. To permit of a simpler bus structure at the rear of the board and to improve the appearance of the front, all fuses are mounted on separate fuse panels at the rear of the switchboard. Ample working

clearance is provided between the rear of the board and the wall.

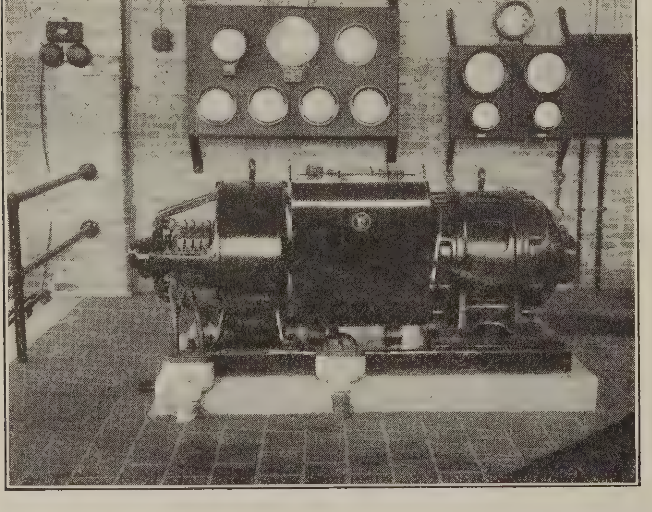
The motor-generator set for battery charging is a direct connected Westinghouse unit mounted on a common bed plate. The motor is a 60-hp., 3-phase 60-cycle, 220 volt, 1,750-rpm. (full load) Type-CS induction motor, while the generator is a 40-kw., 100-volt, Type-SK machine. The compensator is a Westinghouse Type-A auto-starter which operates in a 20-sec. starting period.

The main lighting fixtures in the power plant are Maxolite, RLM dome, enameled steel reflectors. Fourteen-inch reflectors are used with 100-watt lamps and 16-in. reflectors are used with 200-watt lamps. There are in all, 10 Ralco receptacles for extension lamps distributed at various points in the power plant.

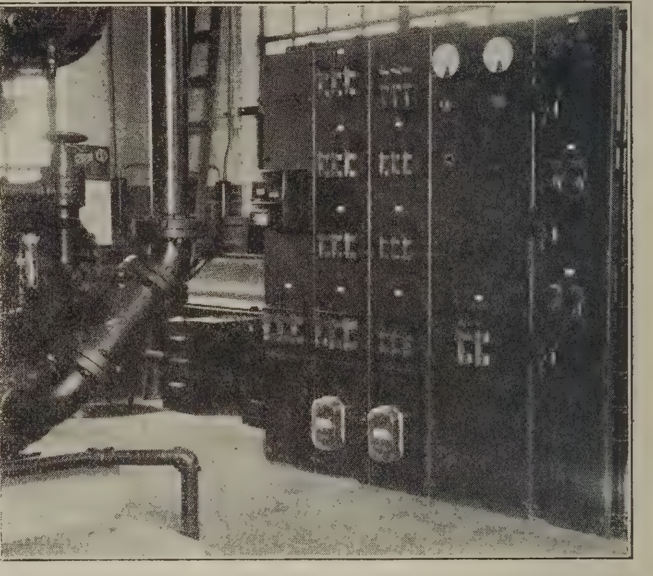
A large advertising sign (Northern Pacific) is mounted on the roof of the power plant and this is floodlighted by means of Pyle-National projectors. This installation includes two 200-watt clear lens types and three 500-watt rectangular divergence lens types all controlled from one of the 3-pole knife switches on the main switchboard. In addition to this sign there is another one on the commissary building lighted by nine 200-watt Pyle-National floodlighting projectors and one 300-watt Crouse-Hinds unit. The Northern Pacific monogram in 4 ft. letters "N. P. R. R." in colored tile is inserted on four sides of the 175-ft. concrete smokestack.

Power and Light Distribution Lines Are Underground

A large amount of parkway cable is installed in tunnels and underground for all power, light and battery charging distribution. Between the power house and commissary building there is a 5 ft. by 7 ft. concrete tunnel in which the steam and air pipes and distribution cables are laid. There is also a smaller tunnel between the power plant and the car shop. The power circuits between these aforementioned buildings are 3-conductor No. 4/0 parkway cable, while the 32-kw., 220-volt, 3-phase, 4-unit electric oven in the commissary is served direct from the main switchboard in the power plant by a 3-conductor No. 2/0 parkway cable. The lighting circuits are 2-conductor parkway cable, there being 750 lineal ft. of No. 2 used for distribution to the lighting cabinets in the battery building, storehouse, Pullman building and commissary and 800 lineal ft. of No. 4 for the two floodlighting towers at each side of the yard. For yard battery charging purposes there are two separate runs of 2-conductor No. 4/0 parkway cable totaling 975 lineal ft., while for the d-c. charging panel in the battery building there are 380 lineal ft. of 2-conductor No. 4/0 cable.



Westinghouse Motor Generator Set in the Power Plant with Boiler Room Gages and Republic Meters (For Soo Line Yard) Mounted on Wall Panels



Main Control Switchboard for A. C. and D. C. Distribution with All Fuses Mounted at the Rear

In the coach yard, 10 tracks are provided for storage and 12 for live equipment. Between the tracks, wooden platforms, six feet wide, facilitate the easy passage of electric trucks and coach employees. In all, about two miles of plank runways are provided. The live equipment tracks have hot (circulated) and cold running water, air and steam connections for the cleaning and heating of coaches and 11 receptacles mounted on concrete foundations for the electric lighting of coaches and charging of our batteries. These outlets are 2-pole, 100-volt, 100-amp., Crouse-Hinds Type-UGEM, while the portable cables, No. 1, 2-conductor, rubber covered, are fitted with a 2-pole receptacle plug on one end and a standard 3-finger train connector head on the other end.

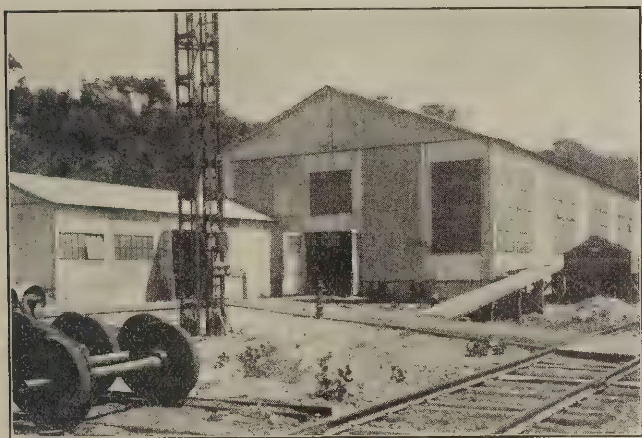
Two Floodlight Towers Insure Adequate Light for Night Operations

At each end of the planked roadway running transversely on the coach yard there is a 65-ft. Bates expanded steel floodlight tower mounting six General Electric projectors. These towers are arranged for one-way lighting and are complete with ladders and inspection platform. Four 1,000-watt projectors fitted with sheet steel cases and "spreadlite" lenses are mounted in one row at the top, below which are two 500-watt projectors equipped with clear lenses. Six separate control circuits in 1¼-in. conduit are carried up each tower from the cabinet at the base. Each projector is individually controlled by means of a snap switch in a Crouse-Hinds

No. GSE-3229 condulet, there being six switches mounted below the distribution cabinet on each tower.

Battery Maintenance and Repair Facilities

While the unit of the coach yard reserved for battery repairs is unpretentious in construction it invites immediate attention for the sharp contrast it affords with the common type of this facility in use at many railroad coach yards. The building is a one-story brick structure with a reinforced concrete floor, a fire resistant mill type roof construction and steel window sash. To protect the floor against the deteriorating chemical action of sulphuric acid it is covered with two ¾-in. layers of asphaltum mastic.



Coach and Wheel Shop Located Across the Yard from the Power Plant

Across one end of this room, five benches are provided for mounting 64-volt, 200 ampere-hour car batteries when charging. Each bench is served with a Ralco, 250-volt, 60 amp., fused receptacle with extension cords and plugs. Three of these receptacles are on one circuit while the other two are on a second circuit. A 2-panel slate switchboard, designed by the railroad and built by the Commonwealth Electric Co., St. Paul, Minn., is used for control of these charging circuits in the battery room. One panel of this board mounts a G. E. Type-C, Form-P, 2-pole, 250-volt, 100-amp. overload and reverse current breaker, while the other contains, in duplicate, metering equipment and a single-pole fused knife switch for each of the two charging circuits. The voltmeters and ammeters are Weston with 0-130 and 100-0-100 scales respectively. Below these are Sangamo Type-NF, 120-volt, 60-amp. ampere-hour meters, to provide for testing the ampere-hour capacity of batteries.

Water for storage cells is distilled in the shop in a steam-heated still having a capacity of 10 gallons an hour. A steam line at 125 lb. pressure from the power plant operates the still. The condensate is collected in a 150-gal. tank. Electrolyte of proper specific gravity is prepared in a 110-gal. stone jar. There is a chain hoist used for lifting acid carboys up to the mixing jar, which has an overhead ceiling runway.

Adjoining the still and electrolyte reducing stand is a large sediment cleaning tank. Battery jars, most of which now in service are of the lead type, can be cleaned easily by mounting them over a special high pressure water nozzle that is capable of flushing out the dirtiest jars quickly. Rubber jars are being used in increasing numbers and with entire satisfaction.

In assembling plate groups and making inter-cell connections, an oxyacetylene torch is used for lead burning. This work is concentrated at a separate work bench.

Another work bench with a sheet metal covered wooden top 2½ ft. above the floor is used for all general battery repairs. At one end of this bench, a 10-in. air cylinder horizontal plate press is mounted with an operating valve within easy reach for control of the 120-lb. air supply. There is an abundance of daylight over this workbench due to its close proximity to three large ventilated windows which extend down to the top of the bench.

The battery room is provided with eight 50-watt mill type lamps in 2¼-in. holders and 10-in. flat cone, steel enameled, Benjamin reflectors suspended from ceiling outlets by short drop cords to a height of eight feet above the floor. These can be reached easily for cleaning by the use of a short step-ladder.

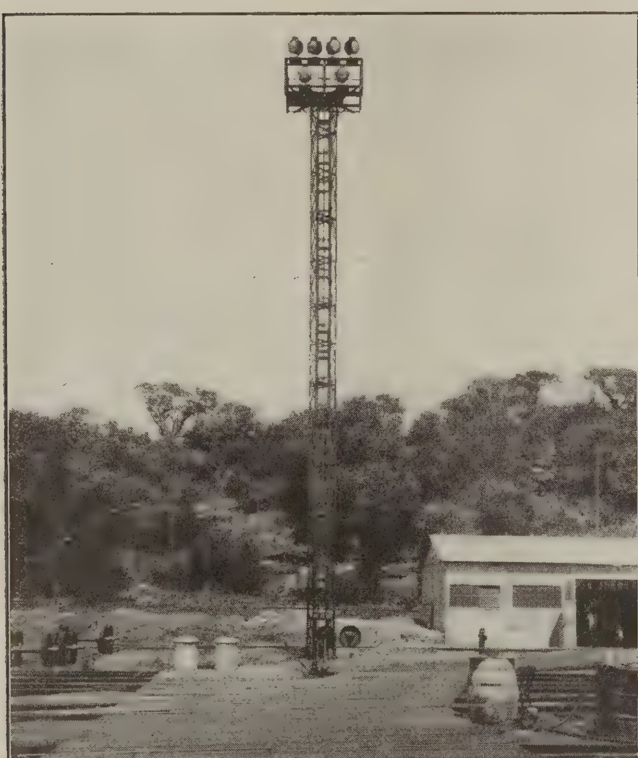
When a set of batteries requires cleaning or overhauling they are slid out of the battery boxes onto one of the platform type electric trucks and transported to the battery room. The truck enters the door near the south end of the room and the batteries are unloaded and placed near a wood strip grating in the floor. The sealing compound is then heated by steam and removed, after which the elements are lifted out of the tanks and placed on the grating for washing. The tanks are then lifted up and placed on an inclined shelf which is attached alongside of and at the top of the electrolyte and washing tanks. In this position the electrolyte runs into the tank. When empty the battery tank is slid over onto the shelf above the washing tank where it is washed out. The tanks are then cleaned, repaired and painted while the elements are repaired, straightened, etc., after which the battery is reassembled and placed on one of the charging benches located along, but at right angles to, the north wall of the room. After the charging and testing has been completed the battery leaves the room through the north door. On an average, positive plate groups are renewed about every six years.

Five Charging Receptacles and Benches Are Provided in the Battery Room

Two Storage Battery Trucks in Service

In an adjoining room there is a repair bench and foreman's headquarters for the yard electricians as well as a separate motor-generator set for charging the batteries on the two platform type electric trucks. This charging equipment comprises a Hertner Electric Company's horizontal type motor-generator with its automatic panel for taper charging two sets of 12-cell, 17-plate batteries in multiple. Provision is made for boost charging one battery when considered necessary. The panel is so arranged that the unit is controlled by the ampere-hour meters on the trucks.

One truck is reserved strictly for commissary service, the buildings being adapted for the operation of electric trucks and trailers. A similar truck is used for transporting car batteries and other coach equipment throughout the yard. These are Baker Type-DUAQ



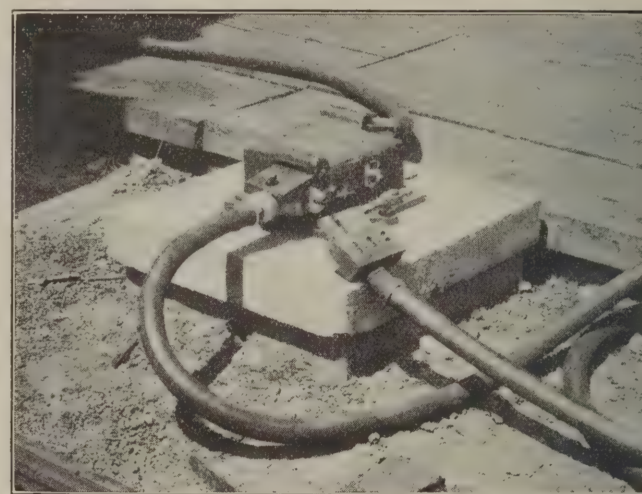
There Are Six G. E. Floodlighting Projectors Mounted on a 65-Ft. Bates Expanded Steel Tower at Each End of the Transverse Roadway

of 2-ton capacity, have a 2-wheel drive, 4-wheel steering year and can be turned in a 5-ft. 5-in. circle. Three speeds are provided, both forward and reverse, the maximum being six miles an hour. Motive power is furnished by an Exide Ironclad battery consisting of 12 Type-MV, 17-plate cells. A Sangamo ampere-hour meter cuts off the battery when fully charged through the separate cord connection with the Hertner panel.

Type-S Electric Wheel Company's industrial trailers with 4-wheel steer, equipped with stake pockets and rubber tired wheels are employed in conjunction with the Baker trucks.

Coach and Wheel Shop

At the east side of the yard across from the boiler plant there is a 50 ft. by 200 ft. coach shop of steel frame construction and sheet-iron covering. The equipment includes a drop pit, motor driven drill press, emery grinder and, in an extension at one end, a 54-in. Putnam wheel lathe which is driven by a 50-hp. Westinghouse motor. The lathe is capable of turning, two at a time, solid steel tired wheels measuring from 26 in. to 52 in. inclusive in tread diameters. Included with it is a pneumatic crane with a 4-wheel trolley for lifting wheels



Crouse-Hinds Type-UGEM, 2-Pole, 100-Volt, 100-Amp. Yard Charging Receptacles Are Mounted on Concrete Piers

into and out of place, and a power traverse tail stock with a pneumatic clamping fixture. This machine has turned as many as 18 pairs of wheels in eight hours.

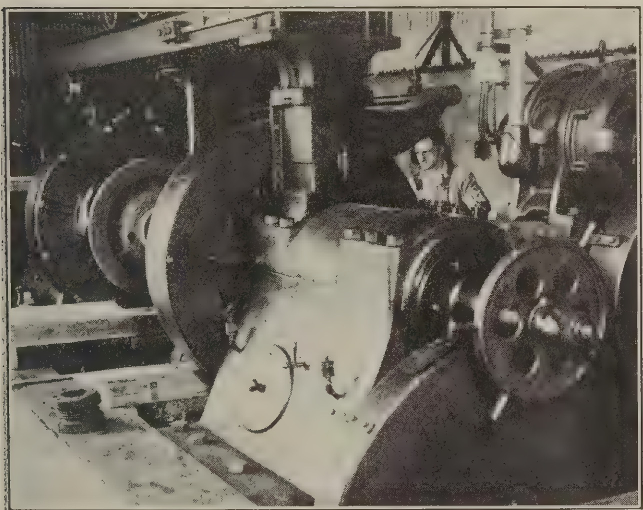
The electrical equipment for this machine comprises the 50-hp. Westinghouse main drive motor (220-volt, 3-phase, 60-cycle, 1,160-rpm. at full load, wound rotor, Type-CW) with its special Westinghouse magnetic wheel lathe controller (Electric Power Club classification No. 55 starting, stop and slow-down resistors) and the 7½-hp. Westinghouse tail stock traverse motor (constant speed squirrel cage Type-CS) with its Westinghouse Type-AF enclosed magnetic auto-starter. Push button control stations for the main drive motor are located at three convenient points within reach of the operator; a 3-position drum switch is used for reversing the tail-stock motor.

An Abundance of Daylight in the Battery Room Affords a Sharp Contrast to the Type of Room Commonly Found

The 28-in. Barnes drill press is belted to a 5-hp. Westinghouse Type-CS induction motor while the grinder has a Cleveland Armature Works 3-hp. Type-A 4.5 motor.

Commissary Building

The main floor includes a linen room, receiving room, grocery storeroom, storekeeper's office, bake shop, butcher shop and six chill rooms. The entire second floor is used for offices. Here are provided private offices for the superintendent of dining cars, assistant superintendent of dining cars, accountant dining car department and a general office for the superintendent's clerks and an office for the accountant's clerks. In the basement will be found rooms for storage of various supplies, a large chill room, a root cellar and a shower bath. The ice machine, brine circulating pump and ice cream freezer are all motor driven. A two-ton electric elevator serves the three floors. The butcher shop is equipped with a motor driven meat slicer and the bake shop is equipped with a four-unit electric oven, an electric humidifier for raising bread and cake sponges and motor driven dough and cake mixers.



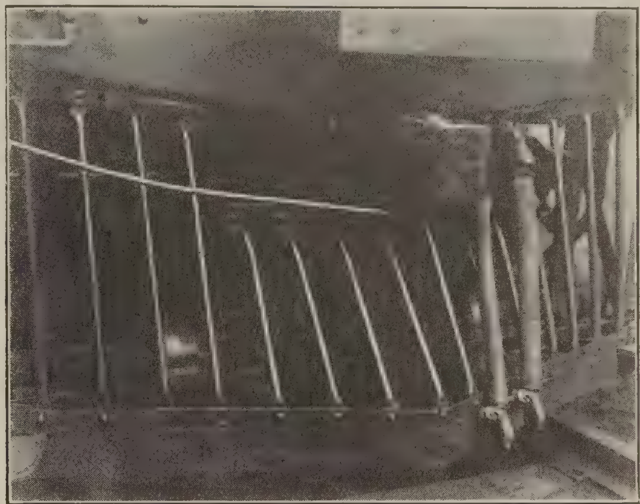
This 54-In. Putnam Wheel Lathe Has a 50-Hp. Driving Motor and a 7½-Hp. Tail Stock Motor Equipped with Full Automatic Push Button Control

The entire commissary building with the exception of chill rooms and basement is illuminated by 100-watt lamps in Attalite Luminaries. Maxolite and Benjamin porcelain steel enameled reflectors of various types in suit conditions are used in all buildings with the exception of the commissary building and in such places where special fixtures are required. All of the lighting distribution panels in all of the buildings are Adams dead front type.

Train Control for Boston & Maine Rail Motor Cars

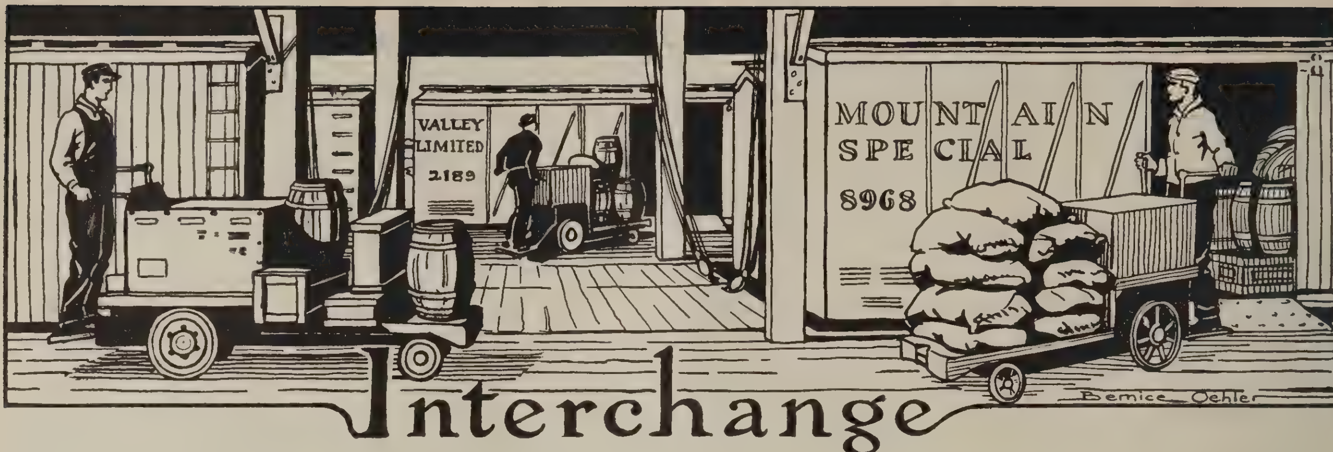
TRAIN control apparatus has been applied to two of the gasoline-electric cars operated by the Boston & Maine Railroad as a part of its fleet of 24 gasoline and gasoline-electric rail motor cars. One of the cars equipped is a 61 ft. car arranged for double-end operation with a control compartment in each end, but equipped with single-end train control to function when operating from the head end only. The car has been assigned to the Boston-Fitchburg run of 50 miles. The car is turned at each end of the run.

The other car is a 73 ft. car, equipped for double-end power plant control and also furnished with double-end train control, this car being designed for operation on the Boston-Marlboro run of 32 miles with turning facilities not available at Marlboro. The train control apparatus used is that which is standard on Boston & Maine train control territory, the Union Switch & Signal Company's automatic continuous train stop with acknowledging feature. The track receiver coils are mounted just back of the pilot and are carried on special brackets secured to the pilot and car body. The corresponding loop receiver coils are mounted on the rear pilot. The equipment box containing the amplifier relay and other electrical equipment is mounted underneath the car body. The cab indicator is mounted in the control compartment directly in the operator's line of vision and the lever of the acknowledging valve is located between the controller and the brake valve.



Special Brackets on the Pilot and Car Body Support the Receiver Behind the Pilot and Six Inches Above the Rails

The Equipment Box Is Mounted Underneath the Car Body

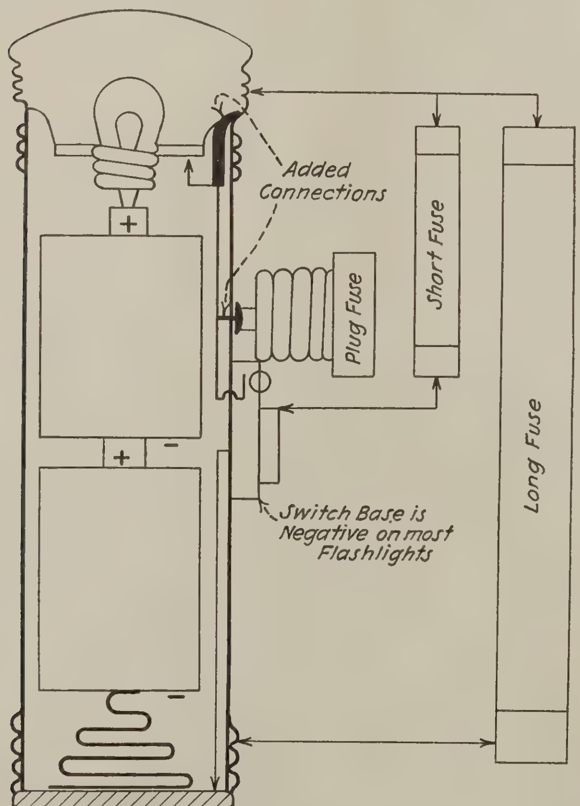


First Prize

Flashlight Fuse Tester

By H. M. Watson
Deer Lodge, Mont.

The fuse tester shown in the illustration has proved very useful on the electrified zone of the Chicago, Milwaukee & St. Paul. The flashlight can be used as such at all times, and the addition of the fuse testing feature increases its value many times to the electrical inspector or trouble man.



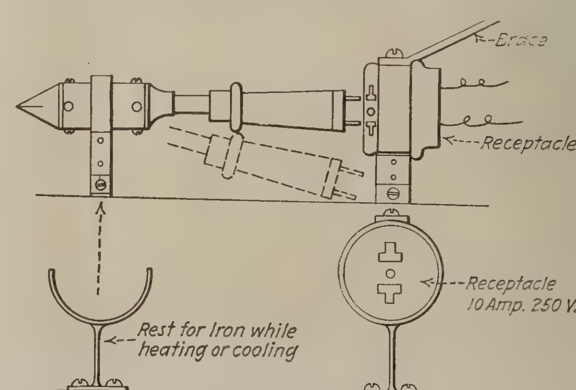
A Handy Device Easily Made

The fuse tester is made from an ordinary flashlight. It is necessary that the casing of the flashlight be of fibre or of other insulating material. The tester is made as follows: First, unscrew the top of the flashlight. Second, solder a piece of sheet brass or tin running to lamp plate (negative side of lamp). Third, solder other end to screw band as shown in sketch. It is now ready for testing cartridge fuses. For testing plug fuses, solder a small contact plate or button (a round head paper fastener will do) to the lamp base conductor. A plug fuse will make contact with the shell or base of the flashlight switch which is the negative side of the battery circuit on most flashlights. All fuses are tested with the flashlight switch in the off position. If the lamp lights with the switch in the off position, the fuse is good.

Cordless Soldering Iron

By H. M. Watson

The cord of an electric soldering iron has always given considerable trouble and in addition, is often dangling in the user's way. The only advantage that might be claimed for the cord is the continuous heating of the iron while in use. Where heavy or continuous soldering is necessary, two soldering irons are generally preferred so that the cord really is of no advantage. The writer has changed a number of soldering irons as described here and has found them very satisfactory.



Details of Construction

While the sketch is almost self-explanatory, a few words concerning it may not be amiss. The receptacle and extension plug cap can be obtained at almost any electrical supply house as they are considered standard stock.

First, remove the binding screws from the plug cap and drill the holes through the cap large enough to permit the use of about No. 4 round head brass wood screws which will hold the plug cap to the soldering iron handle and will also serve as binding screws for the heating element leads. The plug cap can be made to fit the soldering iron handle by filing off the rounding part of the cap until a perfect fit is secured. The clamp and brace for the receptacle and the stand or rest for the soldering iron can be made of light strap iron. While the object is to do away with the cord, the arrangement shown in the sketch does not prevent the use of a cord as it will be seen the wire can also be used the same as any electrical appliance, with a separate attachment cord.

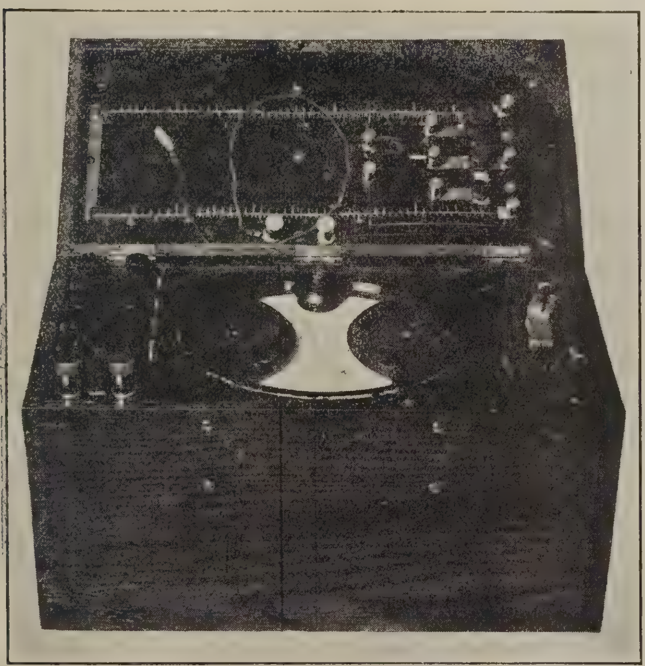
Second Prize

My Helper

By H. N. Griffin

Coach Yard Electrician, C. M. & St. P., Minneapolis, Minn.

While my entry is rather elaborate to be called a "Kink," it is nevertheless a highly useful device for trouble shooting. In fact, it has proved so valuable to me, that since I work alone, I have nicknamed it "My Helper."



General Appearance of "My Helper"

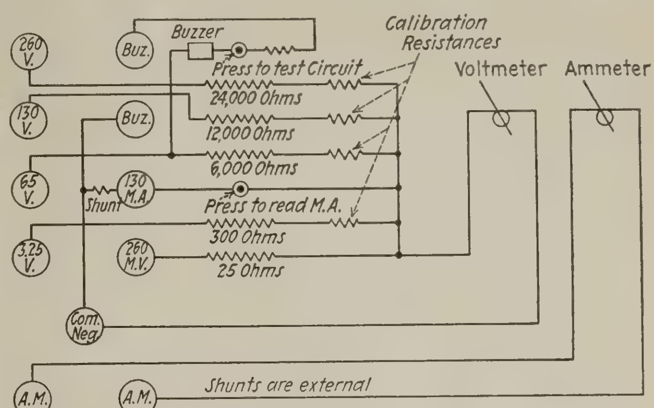
It has repeatedly been of as much assistance as an extra hand could possibly be.

This device is a combination volt-ammeter of numerous scales which I rebuilt from an old Weston vehicle meter, Model 240. It is in a case fourteen inches long, seven inches wide, eight inches high and weighs only fifteen pounds complete.

The voltmeter scales range from 260 milli-volts to 260 volts. The ammeter scales range from 130 milli-amperes to 300 amperes, making use of exterior shunts.

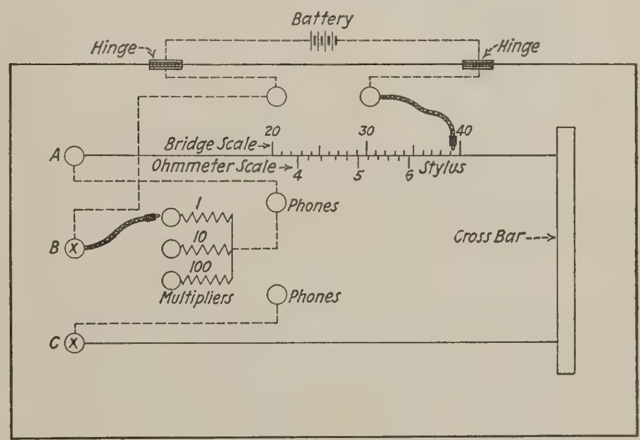
The schematic diagram plainly shows how the different scales were obtained. The reason for having a common negative was for convenience in changing over the original multipliers which were already in the meter.

The two diagrams of the Wheatstone Bridge, which is in the cover, show how it is used as an ohm-meter and for the Murray loop test. It will be noticed the stylus is connected directly to the battery. This was done to avoid changing any connections when changing from an ohmic test to a Murray loop test. A receiver is used first, for a rough test, and then for a final test the



Schematic Diagram of Instrument Case

receiver is removed and a pair of leads connected to the ammeter terminals. By so doing the ammeter is used as a galvanometer. With the stylus connected to the battery, it eliminated the usual battery switch. There is a small inductive effect in this bridge, but this may be neglected for ordinary testing. With the combination of the three fixed resistances, in the ohmic test, I can get a reading of one-one hundredth of an ohm to ten thousand ohms without a greater ratio than ten to one. The battery, which is a small radio "B," is under the



Schematic Diagram of the Wheatstone Bridge and Ohmmeter

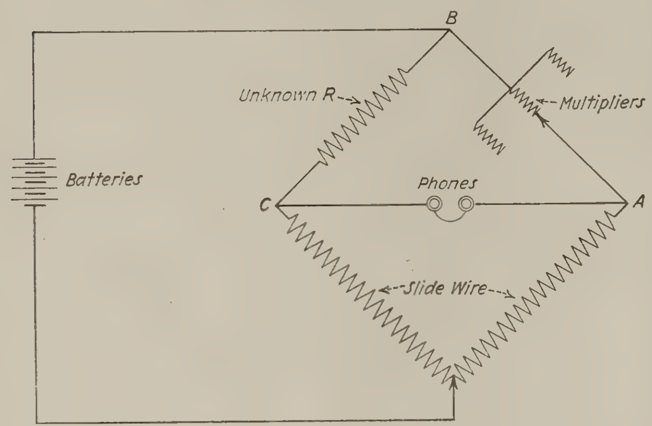
terminal board in the meter case and is connected to the bridge through the hinges.

In the compartment, on the right side of the case, is ample room to carry the following: a small tool roll, a fifteen ampere shunt, a 150 ampere shunt, a 300 ampere shunt, a small receiver, a cadmium stick, two sets of long leads, a set of short leads and a small compass.

The Murray loop test is used to locate grounds in conduit, especially where there are a great number of

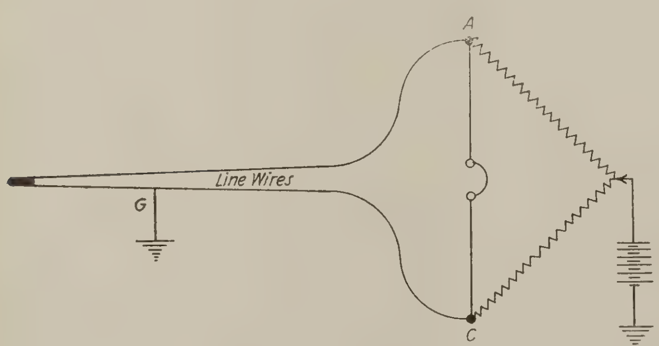
condulets. It will indicate the ground within three to six inches and I have repeatedly used it to locate grounds to the nearest condulet opening. This saves tedious work in opening condulets in search of such grounds which are fairly numerous.

To use the instrument for the Murray loop test: First remove all lamps or other loads from the line or circuit wires to be tested. Connect the two line wires together at one end taking care to get good electrical contact so that the resistance of the joint will not dis-



Simplified Diagram of the Bridge Showing the Relative Location of the Ratio Arms

turb the readings to be obtained. If the grounded side is known, connect that side to point "A" on the bridge. Connect the other wire to "C" using flexible connections from the ends of the circuit if necessary. Here again, care must be taken to see that good contact is obtained and the flexible wires should be as short as possible and both of the same size and length. Provide a suitable ground for the battery from the opposite terminal to which the stylus is connected. Connect phones or meter



Connections for Murray Loop Test

to the terminals indicated and you are ready to manipulate the bridge.

Tap along the slide wire until a point of silence is reached on the phones or no deflection is noted on the galvanometer. Reading on the bridge scale, the percentage of the total circuit length from point "A" to the grounded point of the line is indicated. For this reason it is more convenient to have the ground on "A" and the percentage of the total line length indicated will be the distance from "A" to ground. Otherwise, the percentage indicated would be the distance to the opposite end and back to the ground as shown in drawing.

The ohmic test is used to check fixed resistances on panels and to check field coils. To use the ohm scale, it is only necessary to connect the unknown resistance across the points marked "XX" on the scale, and manipulate the stylus until a balance is obtained and the ohmic resistance of the unknown may then be read directly from the scale.

The milli-volt scale is used to check ammeters, by comparison, or to make a bar to bar test of armatures.

The 3.25 volt scale is used for individual cell readings or in making a cadmium test.

The 65 volt, 130 volt, and 260 volt ranges have their regular uses where direct current is used.

The various shunts give a wide range of accurate readings of the ammeter. The shunts are arranged with knife blades as terminal blocks so that they may be inserted into the fuse clips of a battery or generator circuit to determine its load.

One of the outstanding uses is the magneto attachment, which is the buzzer arrangement as shown in the diagram. The multiplier in series with the buzzer is such that, when 32 volts is impressed on the 65 volt scale, the buzzer is very effective for the use in testing circuits in place of a magneto. This arrangement is very desirable because it will not ring through inductance.

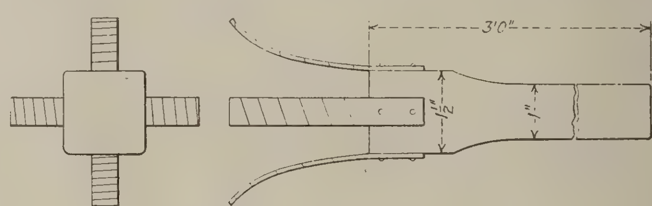
The inclosed battery and receiver are used for testing where the higher voltage would be excessive.

A Lamp Stick

By H. N. Griffin

This "Kink" is called a "Lamp Stick" and is used for applying, renewing, or replacing lamps in coaches, baggage and mail cars. The fact that it is not very elaborate is overcome by its convenience and the safety of its operator.

Considerable time is saved by not having to use a step ladder, a stepping box, a chair, or to stand on arm rests or seats. It is much safer to use than the above



An Easy Way of Making a Useful Tool

methods while cars are in motion or being bumped in switching.

This lamp stick is made of a piece of wood three feet long and one and one-half inches square. On one end, screw four coach window sash springs as shown in the drawing, about one and one-half inches from the top end taper off the corners, in a lathe, or with a plane, so stick will be easier to handle.

Wrap each spring with one layer of rubber tape. This is to keep from scratching lamps or shades, and also adds to the friction of the springs against the lamp.

This lamp stick will safely handle from a fifteen watt to a one hundred watt lamp.

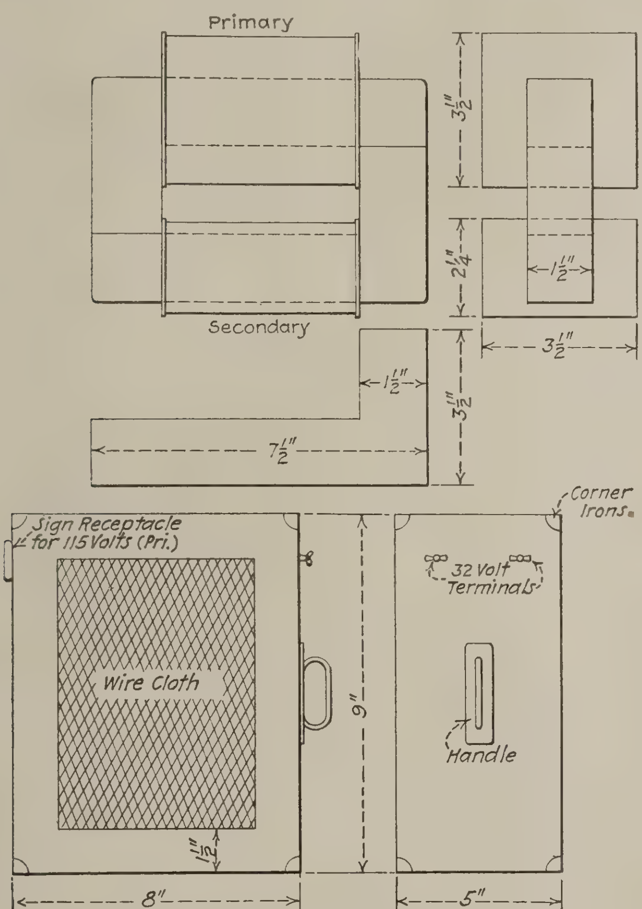
Third Prize

Step Down Transformer for Testing Locomotive Lights

By H. A. Leatherman

The system in use at our shops requires the engines in the back shop to be serviced entirely by the back shop electrician, and the round house electrician is not supposed to have to do anything other than oil the generator when the engines come through. However, many slips have occurred in the back shop, making it necessary for the round house man to go over the engines just out of the back shop. Of course, considerable buck passing between the round house man and the back shop man was indulged in. The usual excuse of the back shop man was that the engine being cold, he could not start the generator and his test with the magneto had failed to show up the defect in question. To avoid trouble of this kind, a transformer was designed so that every lamp on every engine could be shown lighted for the inspector before the engine left the back shop. This solved the difficulty in full. The general data of the transformer is given: Primary (115 volt) 310 turns of No. 12 single cotton enamel wire. Secondary (32 volt) side 86 turns of No. 8 single cotton enamel wire.

The primary required 5½ lb. of wire and the secondary took 4 lb. The laminations were cut L-shape of the dimension shown, and were stacked 1½ in. thick. We had to use old boiler lagging and tobacco signs for laminations, but they worked very well. The windings were wound on paper tubes and slipped over the legs of the core, square fibre washers as shown were made for the ends of the respective windings. It was later found necessary to make two wooden clamps drawn together by ¼-in. bolt and placed across the short legs of the core, to keep the transformer quiet. The whole was encased in a stout wood box with brass corner irons. The two large sides of the box were paneled with wire screen to help keep the transformer cool. We only use it for a few minutes at a time and never have any trouble from heating, although it will warm up a little. A sign receptacle is used to plug in the high voltage side with an extension cord, and wing nut binding screws were provided for the 32-volt side. The entire assembly weighs 26 lb.

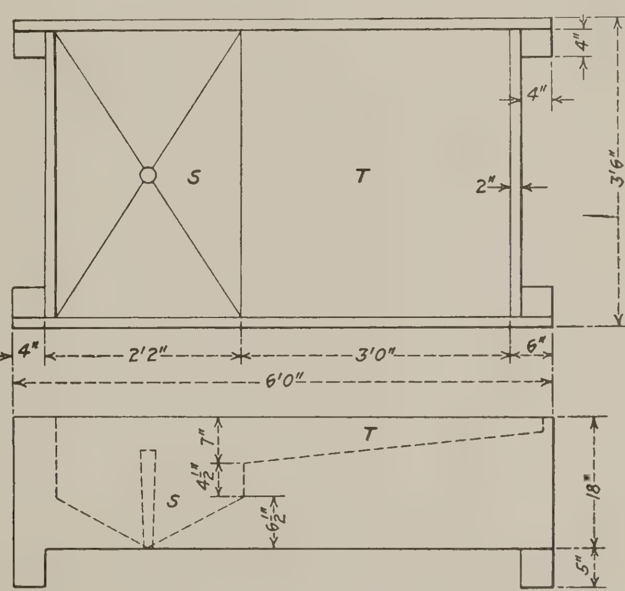


Dimensional Sketch of Transformer Construction

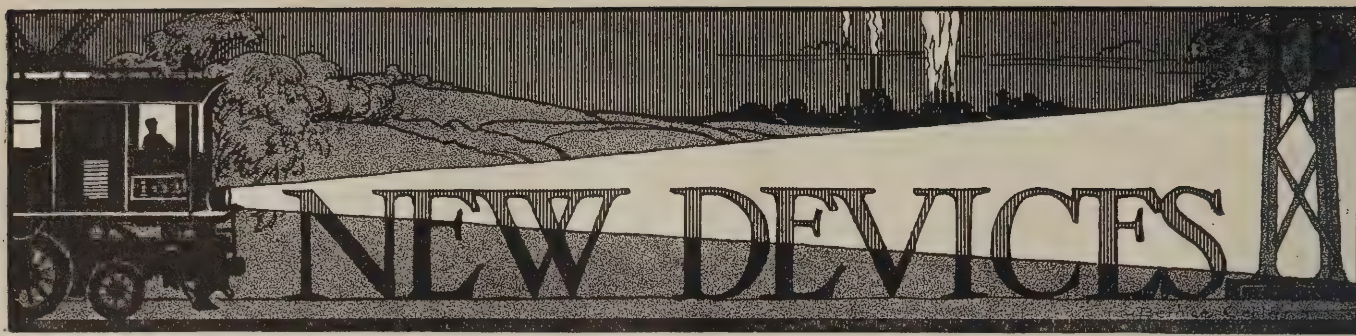
Battery Washing Sink

By H. A. Leatherman

A small battery shop is located at one of our branch terminals, and as the number of batteries handled is not great, no extensive equipment is installed, but the battery sink, shown in the illustration was designed by the local electrical supervisor, and has proved very successful in the three years that it has been in use. It consists of an oak frame, made of 2 in. stock and supported by four 4 in. by 4 in. legs. A long sloping shelf *T* is provided for setting the battery elements upon as soon as they are withdrawn from the tanks. The electrolyte drains down into the sink portion *S*, and out through the drain at the bottom. A lead pipe slightly cone-shaped is used as a stopper in the drain hole. It fits loosely and can be removed readily, or when in place provides both a stopper and an overflow. With the stopper in place, the sink provides a basin of water in which to immerse negatives or for any other purpose. A hose connection is located next to the battery sink and a short length of hose is used to wash plates after they are placed on the shelf *T*. Hot water can be obtained in the deep portion *S* by the insertion of a steam hose, located near by. Hot water is used for straightening tops, and removing sealing compound from linings. The inside and top edges are lined with sheet lead, and the outside with hot asphaltum.



How the Sink Is Constructed



Mill Type Compensator

To meet the demand for a compensator which will cover ratings above 30 hp. on 220-volt circuits and 60 hp. and up on 440 and 550-volt circuits, the General Electric Company has introduced a new design designated as size No. 2. Two-part construction is employed in order to meet a wide variety of installation requirements.

One unit of the compensator consists of an oil-immersed, double-throw switch with temperature overload relay, push button station and undervoltage release.

Compensator Control Unit Consisting of Main Switch, Overload Relay, Under Voltage Release and Stop Button

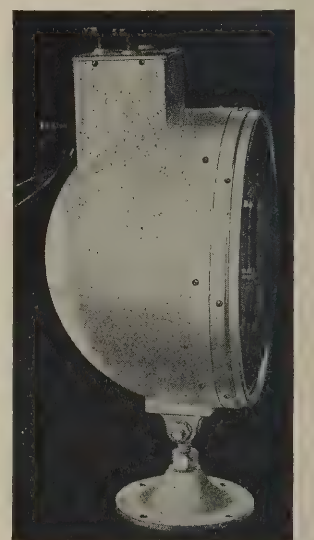
The other unit consists of an auto-transformer. Each unit is provided with a conduit box.

The control box is so arranged that the oil box may be lowered to allow examination of the switch parts and renewal of fingers and wedges. This unit can be wall mounted or attached to a pipe support as may be desired.

The auto transformer is inclosed in a cast iron box with a removable cover to allow changing tap connections when desired. The conduit box mounted on the top of this case provides ample room for making connections. The front of the conduit box is removable, the entire interior thus being accessible in order that joints may be tightened and properly taped.

Flood-Light With Fluted Glass Reflector

A short range floodlighting unit with a fluted glass reflector, known as No. FL-300, is now being marketed by the Pittsburgh Reflector Company, Pittsburgh, Pa. The unit consists of a base, a semi-spherical metal casing, a cowl and focusing device, a reflector and a cover fitted with heat resisting cover glass.



The Unit Provides a Broad Light Distribution With a Low Wattage Lamp

The metal of the housing is sheet steel, tinned and painted. The unit has a mogul socket carried on a focusing mechanism making possible movements of the lamp in all directions, which permits accurate focusing. The cover and casing are threaded so that the cover may be screwed on. A rubber gasket on the casing against which the cover is screwed, makes the unit weather-proof. The finish is aluminum. The height over all is 21½ in., the width, 13 in., and the depth, 9⅛ in.

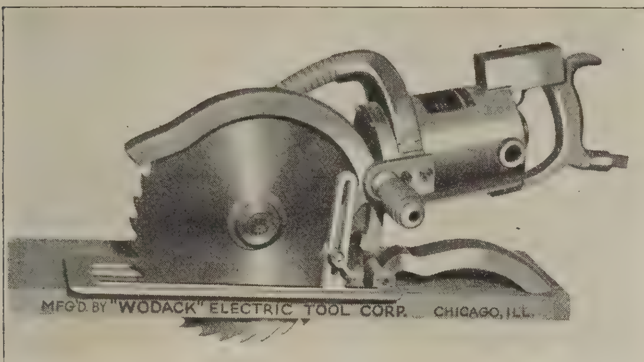
The unit is designed for use with the 300 watt standard Mazda "C" lamp, but by the use of a socket reducer a 200 watt lamp may be used. Up and down focal adjustment extends over a range of two inches in order to permit of the use of the 200 watt lamp.

When the lamp is at the focal center maximum concentration is secured. Under these circumstances the width of the important part of the beam is 20 degrees. With the lamp one-half inch back of focal center, maximum spread is secured. Under this condition the width of the beam is approximately 30 degrees.

Electric Hand Saw for Cutting Lumber

Weighing not over 24 lb. and fitted with a motor large enough to drive an 11-in. circular saw, are some of the features of a new electric hand tool placed on the market recently by the "Wodack" Electric Tool Corp., 23 S. Jefferson street, Chicago. The "Wodack" electric hand saw having a universal motor can be operated from any 110-volt light socket. A depth gauge is provided so that the saw can be adjusted to saw only to the

exact depth necessary, thus preventing any injury to the contents of a packing box when the tool is used to open the cover. It is claimed that with this saw a 4-in. by 4-in. timber can be cut in less than two seconds and that its use will enable an operator to do ten times as much sawing as he can do with an ordinary hand saw. It is essentially a labor saving tool and should find an increasing application not only in construction work



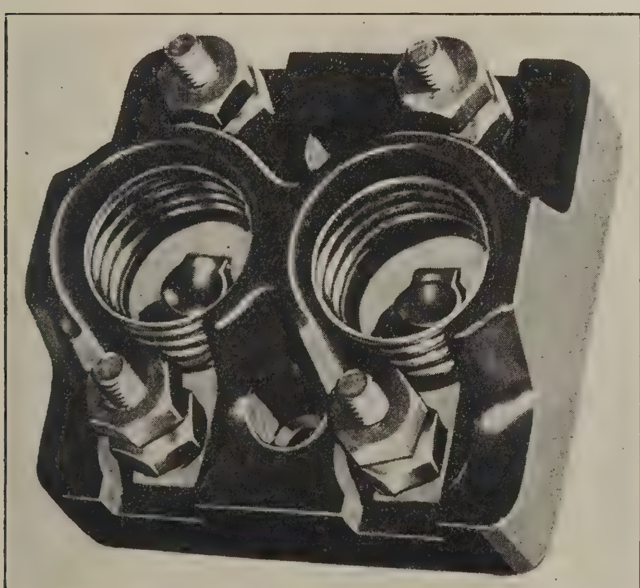
"Wodack" Electric Hand Saw Has a Motor Large Enough to Drive an 11-In. Circular Saw

but for such operations as opening shipping boxes and crates, and other tasks found in railroad shops, storerooms and yards.

Electrical contractors have found this tool useful in cutting floor channels when laying conduit and it is believed electricians will find many other time-saving applications.

Double Pole Fuse Block

The latest of the new Oliver Electric Appliances is the double pole fuse and cutout block shown in the illustration. Substantial design and the use of moulded



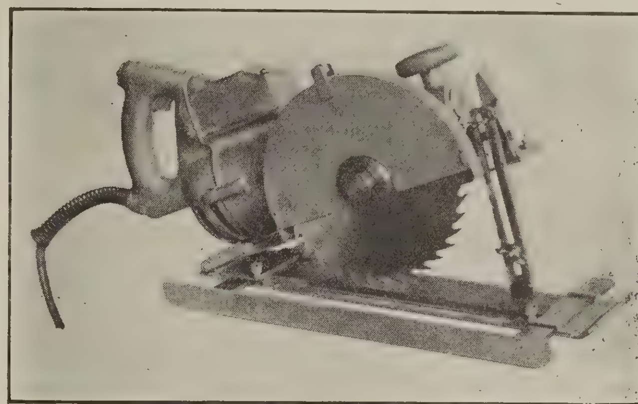
Double Pole Fuse and Cutout Block of Moulded Insulation

insulation insure dependable service under severe conditions. Contacts are furnished with standard RSA brass terminals and RSA brass nuts. These features insure positive connection. Oliver Electric Appliances are manufactured by The Pyle-National Company of Chicago.

Portable Electric Saw

Two electrically driven portable hand saws have been developed by the Electro Magnetic Tool Company of Cicero, Ill. The smaller of the two saws, No. 177, weighs 15 lb. and is capable of cutting almost any kind of material, including light gauge soft metal. The motor brushes and commutator are exposed by the removal of one screw. The control is by a quick make and break trigger switch located in the handle. It is provided with a dust shield which can be removed without the use of tools and the saw blades may be either 6 or 7 in.

The larger of the two saws is shown in the illustration.



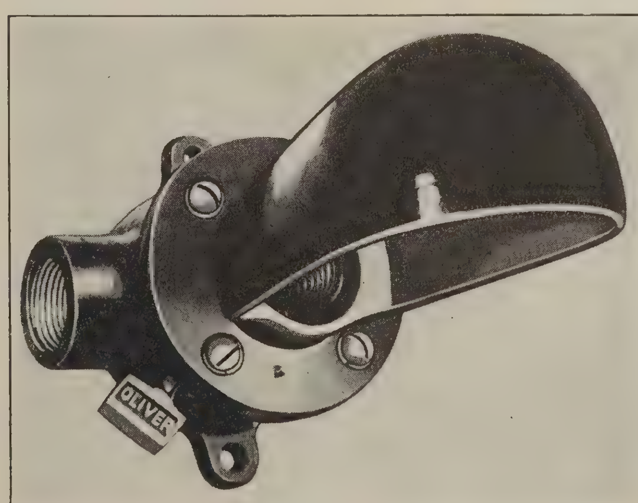
Portable Electric Saw Equipped with ½ Hp. Motor

This device weighs approximately 22 lb. It is known as No. 178 and is intended for heavier work.

Universal motors are used for both saws so that they will operate from a 110-volt lighting socket. If desired, the tools may be obtained to operate on 220-volt or 32-volt circuits at a slight additional cost.

Mail Car Door Light

The new mail car door light fixture of the Oliver Appliances, manufactured by The Pyle-National Company, is illustrated here. This fixture is a substantial,



Mail Car Door Light Fixture

specially designed light for mail car door service, with the reflector integral with the housing. The moulded receptacle has a heavy insulated metal key switch. This fixture meets the Post Office Department requirements.

GENERAL NEWS

The Graybar Electric Company has opened larger quarters for its Detroit, Mich., branch at 55 West Canfield street.

Electric Controller & Manufacturing Company, Cleveland, Ohio, announces the appointment of Farr Electric Service, Inc., 228 W. South Temple, Salt Lake City, as its representative.

The Union Pacific has granted wage increases of approximately two cents an hour to 12,000 shop employees and 2,000 miscellaneous workers, including mostly trackmen, linemen, mechanics and helpers. The shopmen's increase will be effective December 1 and those for other employees January 1.

Square D Company, Detroit, announces the transfer of F. J. Holzhauer from Columbus, Ohio, to the position of branch sales manager at Cincinnati, with office at 309 Mercantile Library Building. W. D. Clark, formerly of the Cincinnati territory has been moved into the Pittsburgh office, 613 Bessemer Building. The Milwaukee office of the company, in charge of H. R. Allen, has changed its address to Room 913, First Wisconsin National Bank Building.

Bridgeport Brass Company, Bridgeport, Conn., announces the appointment of Mifford R. Runyon as manager of its New York office. Mr. Runyon was educated as a chemical engineer. Subsequently he was engaged in wholesale hardware business and later traveled for four years through South America as a public accountant. Afterwards, Mr. Runyon was connected with the Benson Rolling Mill, one of the oldest brass and bronze manufacturing mills outside of Connecticut.

The Department of Commerce has issued statistics illustrating the increase in the number of poles purchased by steam and electric railroads, electric light and power companies and commercial telegraph and telephone companies during recent years. In 1925 there were 3,281,514 poles purchased as compared to 3,060,794 in 1923, an increase of 220,720 or 7.2 per cent. The increase in the use of pine poles is very marked, the number purchased in 1925, 675,730, representing an increase of 68 per cent over the number purchased two years previous (402,393). Of the total number of pine poles purchased in 1925, 607,447 were treated and 68,283 untreated, indicating that almost 90 per cent of all pine poles used in 1925 were treated. Both cedar and chestnut showed a decrease in consumption for pole uses, the former being purchased to the extent of 1,692,870 poles in 1925, as compared to 1,704,247 in 1923 (a decrease of 11,377) and the second to the extent of 776,263 poles in 1925, as compared to 808,509 in 1923 (a decrease of 32,246).

B. & M. Employee-Stockholders

Employees of the Boston & Maine Railroad are now stockholders in the company to the number of about 1,000, as a result of the plan by which they have bought new seven per cent prior preference stock. Employees in all departments have bought shares. Employee subscriptions were limited under the offering. About $300,000 has been invested by employees, in addition to such stock as they may have owned previously.

The plan provides for buying shares on the installment plan with deductions from the payroll at the rate of $2 per share monthly, and the payments will require 44 months. Employees are protected against any unforeseen shrinkage in the market value of the stock during the installment period by provisions for cancellation.

Pullman Employees Instructed in First Aid

Nearly 600 Pullman Company employees have either received Red Cross certificates for graduation in the first aid course or are now in training. The purpose of the course, which was inaugurated several weeks ago, is to teach men to think in terms of physical suffering, to cause them to view unusual situations in terms of safety, to create a tendency to put one's self mentally in the victim's position and to induce the pupil to study how to keep himself from being involved in an accident; to impel a man to analyze his particular job, and to urge men to take more interest in their physical well-being. A class of 25 safety supervisors, yard men and porters were first given a special course in Chicago, and these

men later organized classes in New York, Chicago, Washington, Buffalo and San Francisco.

The course requires 15 hours' time from each pupil; or 1½ hours a week for 10 weeks. The Pullman Company furnishes instructors, material, text-books, etc., free. Technicalities are eliminated and fundamentals only are taught, such as shock, hemorrhage, artificial respiration, mobilization of fractures and the proper ways to lift and carry injured persons.

According to present plans some 600 additional employees will begin a 10 weeks' course after the Christmas holidays.

Advances in Wages

The Delaware, Lackawanna & Western, the Lehigh Valley and the Reading have granted increases of pay of two and three cents an hour, to shopmen, carmen, car cleaners and laborers.

The Pennsylvania has advanced the pay of telegraphers two cents an hour, the advance taking effect as of October 1. The number of persons affected is about 5,800.

Clerks, freight handlers and station employees on the New York Central have asked for an increase of six cents an hour in their pay and, following several conferences, it has been agreed between the company and representatives of the employees to refer the matter to arbitrators. The arbitrator on behalf of the railroad will be F. N. Melius, general superintendent of New York Terminals.

Clerks of the Reading Company to the number of 3,600, together with telephone operators, baggage employees and others, have had their pay advanced five dollars a month, to take effect as from November 1.

The St. Louis Southwestern has granted an increase of 2 cents an hour for mechanics, 1½ cents for intermediate workers, and 1 cent for apprentices and helpers, following a conference between officers of the road and representatives of the Carmen's Association. The increase, effective November 1, will affect about 400 men. Members of the locomotive department have presented a petition asking for a raise in their group.

Panama Canal Tolls Almost 23 Millions

The annual report of Governor Walker, of the Panama Canal, shows tolls collected in the fiscal year ending with June last, amounting to $22,931,055, the same having been collected from 5,197 ships. The number of vessels was increased 524 over the number registered in the preceding year and the tolls were recorded more than $1,500,000 greater.

Indian Railways Order British Equipment

The South Indian, says Commerce Reports, is reported to have placed an order for 8 freight locomotives and tenders with Nasmyth Wilson & Co., Ltd., of Manchester, England. The Great Indian Peninsula Railway has given the English Electric Company at Preston, an order for 15 motor coaches and 42 trailer coaches, as well as for electrical machinery for the road's electrified extension. These orders are taken to be the result of the British government's urging the Indian government to proceed with long-contemplated railway projects. It is also reported that Indian contracts have been placed with the Leeds Forge Company for 142 freight cars for the Indian State Railways, 60 freight cars and 10 trucks for the South Indian Railway, 40 cars for the Bengal-Nagpur Railway and 60 cars for the Jodhpur-Bikanir Railway.

Special Studies for Pullman Shopmen

The Pullman Car & Manufacturing Corporation, during the winter months, is giving a course of training in production methods to approximately 1,000 employees in both the Pullman (Ill.) and Michigan City (Ind.) plants. The course is specifically and definitely a car building course based largely upon the experience of the executives of both plants and consists of six units, (1) team leadership; (2) handling men; (3) handling equipment; (4) organization; (5) plant records; and (6) management. Each unit can be read easily in a few hours and is accompanied by a shop problem. Each unit is used as a basis for departmental meetings in which principles are applied directly to each man's work. In addition, a lecture is given in which the principles can be clarified and application to special problems brought out. A general meeting will be held at four-week intervals and these will be supplemented by four smaller meetings. Departmental meetings are held one week before the general meetings.

Personals

John H. Rodger, vice-president in charge of the Chicago office of the Safety Car Heating & Lighting Company, has been promoted to vice-president in charge of railway sales, with headquarters at New York. George H. Scott, representative at Chicago, has been promoted to manager of the Chicago office and Carl A. Pinyerd, for the past few years district engineer in the Chicago office, has been promoted to commercial engineer with the same head-headquarters. John H. Rodger began work in 1899 with the Standard Coupler Company, New York, leaving that service in 1905 to become assistant to the president of the Monarch Machine Company. He was then for a time engaged in other business and returned to the railway supply business in April, 1911, when he entered the service of the Safety Car Heating & Lighting Company, and was assigned to the Chicago office as a sales representative. Subsequently he served as acting vice-president and later as western manager until his appointment in June, 1922, as vice-president, with the same headquarters, which position he held until his recent promotion to vice-president in charge of railway sales, with headquarters at New York.

J. H. Rodger

F. E. Case, who for many years has been in charge of the railway equipment engineering department, of the General Electric Company, Schenectady, N. Y., has had added to his duties the supervision of the railway motor and railway locomotive engineering departments.

H. F. Darby, Jr., 1700 Walnut street, Philadelphia, Pa., has been appointed direct factory representative in the Philadelphia district of the Kuhlman Electric Company, Bay City, Mich. For more than 20 years Mr. Darby was with the Cutter Electrical & Manufacturing Company and during the last six years he was sales manager of that organization.

Obituary

David J. Cartwright, electrical engineer of the Lehigh Valley and one time president of the Association of Railway Electrical Engineers, died at his home in Boston on December 1, after a lingering illness of two years. Mr. Cartwright was born in Boston in 1861. He was educated in that city having taken a special course in electrical engineering in the Massachusetts Institute of Technology. Mr. Cartwright was early interested in the electric lighting of railway coaches having installed a primary battery system of electric lighting in a B. & P. R. R. coach in the early days. From 1887 to 1898, however, he was side tracked on general construction work and during the Spanish War, he was employed on torpedo defense work in Boston and continued in that department until 1902, during which time he had charge of all electric construction and submarine work connected with Boston Harbor and vicinity.

David J. Cartwright

The next few years were devoted to the development of some of his own electrical inventions both here and abroad in connection with the operation of guns on board ship, fuses for projectiles, internal combustion engines and carburetors.

From 1905 to 1907, Mr. Cartwright was in charge of electric lighting on the New York, New Haven & Hartford road, and in 1908 he entered the employ of the Lehigh Valley where he has been in charge of car-lighting ever since.

Trade Publications

Safety car lighting battery type CLEG is described in detail in a 12-page illustrated booklet issued by the Safety Car Heating & Lighting Company, New Haven, Conn.

Asbestos Shingle, Slate & Sheathing Company, Ambler, Pa., has recently issued a small illustrated booklet describing the use of Ambler asbestos lumber in connection with the installation of electrical equipment.

The American Brown Boveri Electric Corporation in its descriptive circular No. 400 illustrates electric locomotives with individual axle drive of its design, pointing out the advantages of this particular form of drive.

Effect of Surface Materials on Steel Welding Rods is the name of a 26-page booklet published by the Chicago Steel & Wire Company. The booklet concerns itself chiefly with information relative to the properties and characteristics of welding rods.

The application, construction and engineering specifications of air-brake disconnecting switches are discussed in two leaflets recently prepared by the Westinghouse Electric and Manufacturing Company. L-25408 takes up the description of the Type RH while the type RV air-break disconnecting switches is discussed in L-25404.

Wound rotor induction motor of "900" series is the subject matter of a one-page bulletin recently published by the General Electric Company. Type MT 3-phase and type MQ 2-phase of constant and adjustable varying speed, at 220, 440 and 550 volts are included in this series. The sizes range from ¾ to 10 hp. and are rated at 40 degrees centigrade continuous duty.

Square D Company, Detroit, Mich., has just issued its catalogue No. 32. The book is 5 in. by 7 in. in size and contains 88 pages. The new catalogue lists a complete line of industrial switches and also includes standardized meter service switches, convertible power panels and electrical porcelain. The catalogue is of the loose leaf type so that new pages can be added at any time.

The Cutler-Hammer Manufacturing Company, Milwaukee, recently issued a 36-page illustrated book bound in cardboard cover entitled "Industry's Electrical Progress." It tells a story of the progress made in the development of motor control apparatus and points out that the competitive advantages which electric power brings to industry lies in the effectiveness with which electricity is utilized.

Two recent publications of the American Brown Boveri Corporation are entitled "Turbo Compressors and Blowers" and "Mercury Arc Power Rectifiers." Both publication are well illustrated. The former describes the various types of turbine equipment that the company manufactures and the latter gives the construction principles and details of large mercury arc rectifying apparatus.

Railroad Electrification Data, a pocket-size handbook of 96 pages, has been released by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. In part one of the book has been included sufficient elementary information to make the publication of value to those employes of steam railroads who have not had technical training but who find it necessary to become informed on electric locomotive equipment and its operation. Part two is composed of information about and diagrams of typical electric locomotives that are now in service throughout the world. Also, there are useful tables of helpful information on steam locomotives, freight cars, train resistance, etc., in this part.

Power Illumination

Railway Electrical Engineer

Heavy Electric Traction Train Lighting Train Control

DECEMBER, 1926

FIGHTING OIL FIRES

Every precaution is taken by the large oil com-panies to prevent fire but they are well equipped to fight a fire and prevent its spreading if one does occur.

Pictured above is the station from which chemicals are pumped and distributed for fighting a fire in the plant of the Associated Oil Company at San Francisco.

An EC&M Automatic Compensator is installed in this station for controlling the operation of the electric motor which drives the fire pumps. Push button control through this Compensator makes it possible for anyone, without previous training, to start these pumps correctly.

This Compensator has its working parts totally immersed in oil and sealed in a cast iron case. No matter how infrequent its operation may be, this Compensator is always ready for work when the emergency arises.

Write for Bulletin 1042-F

THE ELECTRIC CONTROLLER & MFG. CO.

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PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
SEATTLE-570 COLMAN BLDG.
TORONTO-METROPOLITAN BLDG.

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New England Pioneers In Railroading

One in a series outlining early developments on railroads using Phono-Electric.

Railroading in the United States was born when the first stone for the Bunker Hill Monument was carried over the famous horse and gravity operated tram road in Massachusetts. To a Yankee, who was also the inventor of a high pressure engine in 1800, goes the credit for the first amphibious steam locomotive. It was provided with four wheels, upon which it traveled by land, and with a paddle wheel in the rear for use in the water. In fact, New England ingenuity in railroading has left a record of successful pioneering efforts down to our own times, when the New York, New Haven and Hartford took the initial step in the heavy electrification of steam roads.

An analogy to the quaint double purpose locomotive is seen in the necessity which faced the New Haven of developing an electric locomotive which would operate equally well on a single-phase alternating current from an overhead contact system and with 600-volt direct current, furnished from a third rail.

What this great system has accomplished is now history. Phono-Electric is practically the only material employed for contact wire on the main line. Its great tensile strength, high resistance to wear and exceptional non-corroding qualities have made it preferable to copper or steel for this severe service. Phono costs more per mile but less per year.

"Bridgeport" BRASS CO. TRADE MARK
Phono-Electric

WE MAKE
Ledrite Brass Rod
Phono-Electric Contact Wire
Plumrite Brass Pipe
Phono-Hi-Strength Wire
Tubular Plumbing Goods
Condenser Tubes-Sugar Tubes
Brass, Bronze and Copper Sheets
Brass, Bronze and Copper Tubes
Auto, Bicycle and Pressure Pumps
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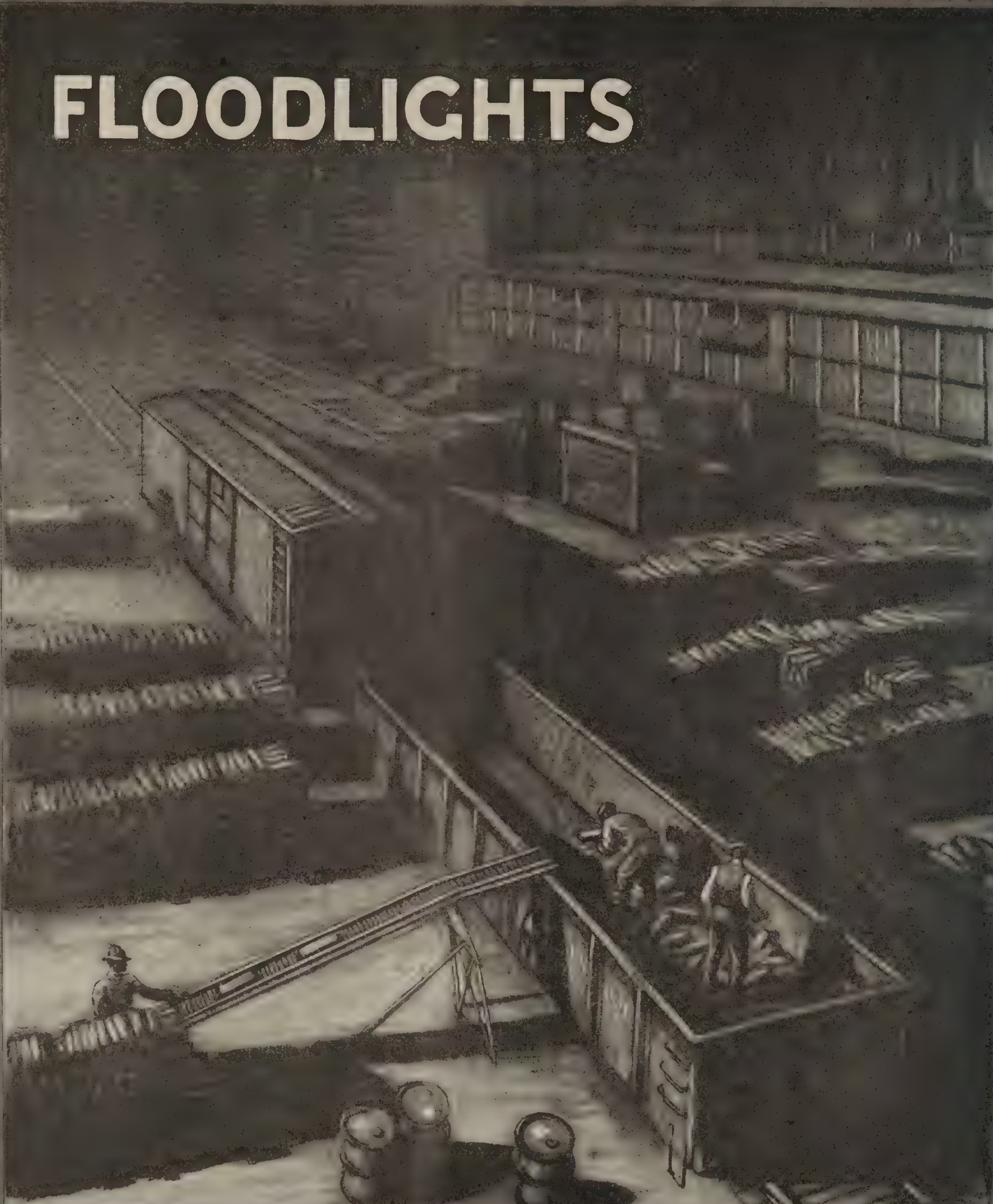
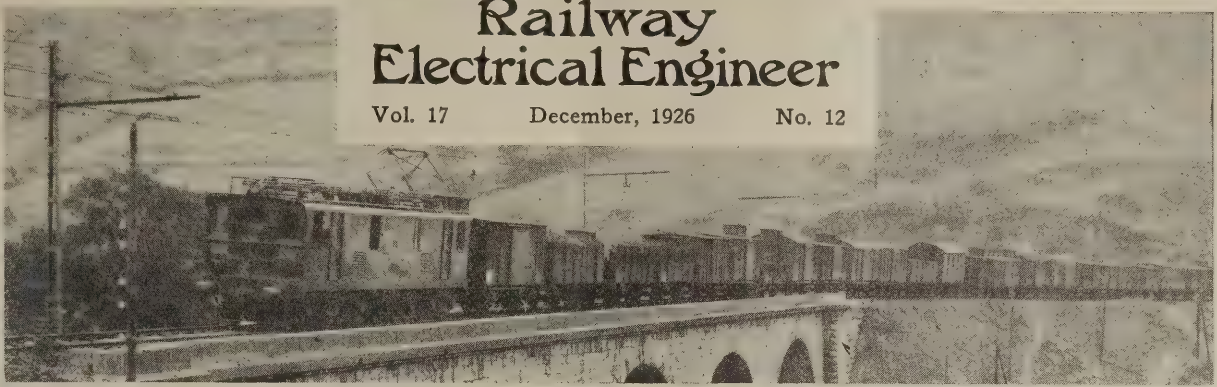
Electric Furnace Products


FLOODLIGHTS

Railway
Electrical Engineer

Vol. 17 December, 1926 No. 12



Spanish Northern Freight Train With G. E. Electric Locomotive

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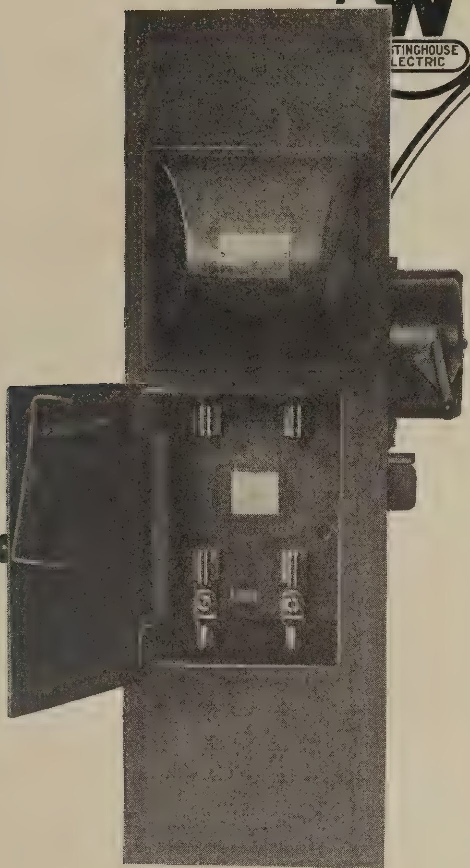
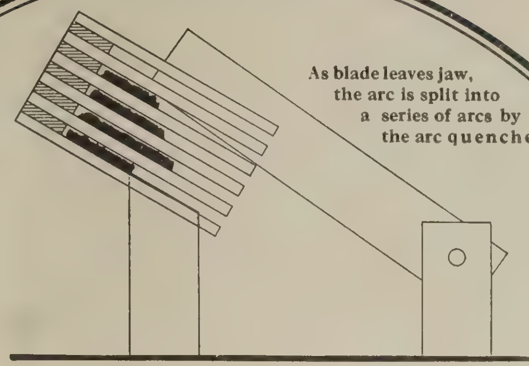
REQUEST for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your OLD address as well as the NEW one.

The Railway Electrical Engineer is a member of the Associated Business Papers (A.B.P.) and of the Audit Bureau of Circulation (A.B.C.)





For Full Safety

The Arc Must Be Quenched

Arcing when a switch is opened under load is dangerous and destructive. That's why Westinghouse full safety WK-55 switches are equipped with an arc quencher that splits up the dangerous arc and effectively quenches it. There is no danger from arcing at voltages of 550 a-c. or 600 d-c.

The arc quencher is a distinctive feature of Westinghouse type WK-55 switches. It's an assurance of full safety.

The WK-55 is built, in capacities of from 30 to 1200 amperes, to meet the severest requirements of industrial service. It's a tough switch, a long-life switch, one you can install with the confidence of successful operation.

The diamond pointed jaw and extended blade give maximum clean contact surface. The double door construction protects your men and saves time in fuse replacement. The simple, positive, quick-make and quick-break mechanism in the operating handle leaves clear wiring space within the box.

This line also includes the full safety steel mill type, a two-pole fusible switch, built in capacities of from 30 to 600 ampere, for 250 volt service.

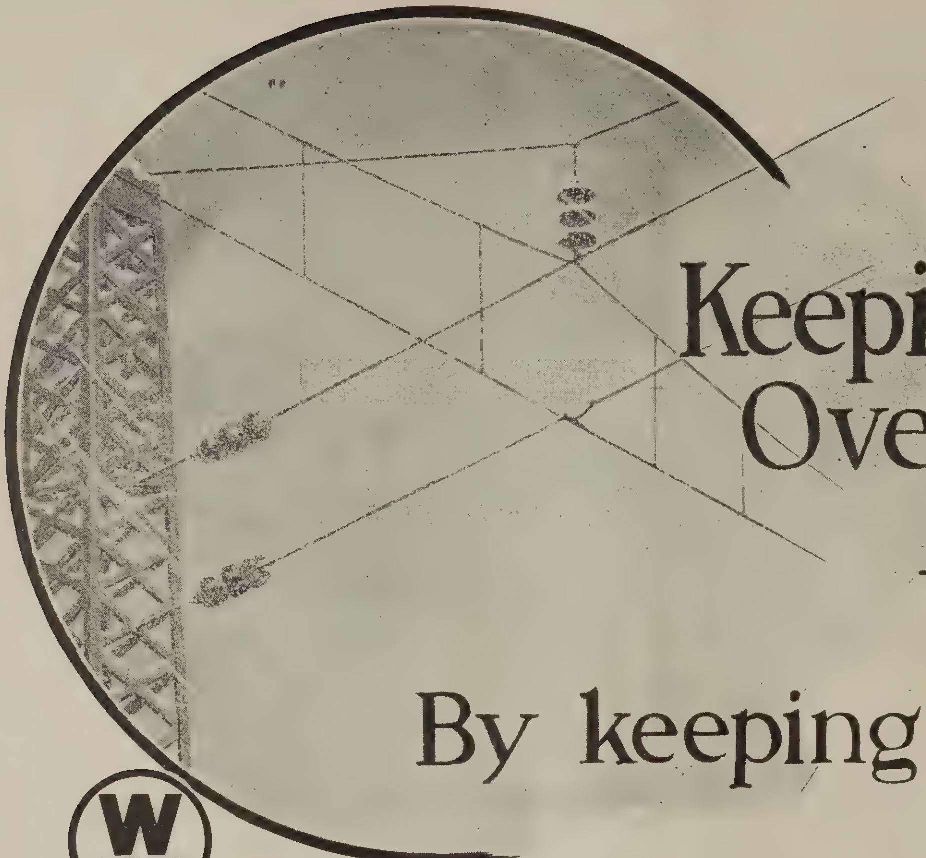
Write the nearest Westinghouse Office for your copy of the new Westinghouse Safety Switch Catalog.

Westinghouse Electric & Manufacturing Company
Merchandising Department Mansfield, Ohio

Westinghouse

X87809

Long Life Switches



Keeping the Overhead *Down*

By keeping it UP

WESTINGHOUSE ELECTRIC

IF overhead line performance is to be dependable—and maintenance a minimum—none of the hazards that affect the "overhead" can be trusted to rule-of-thumb installation.

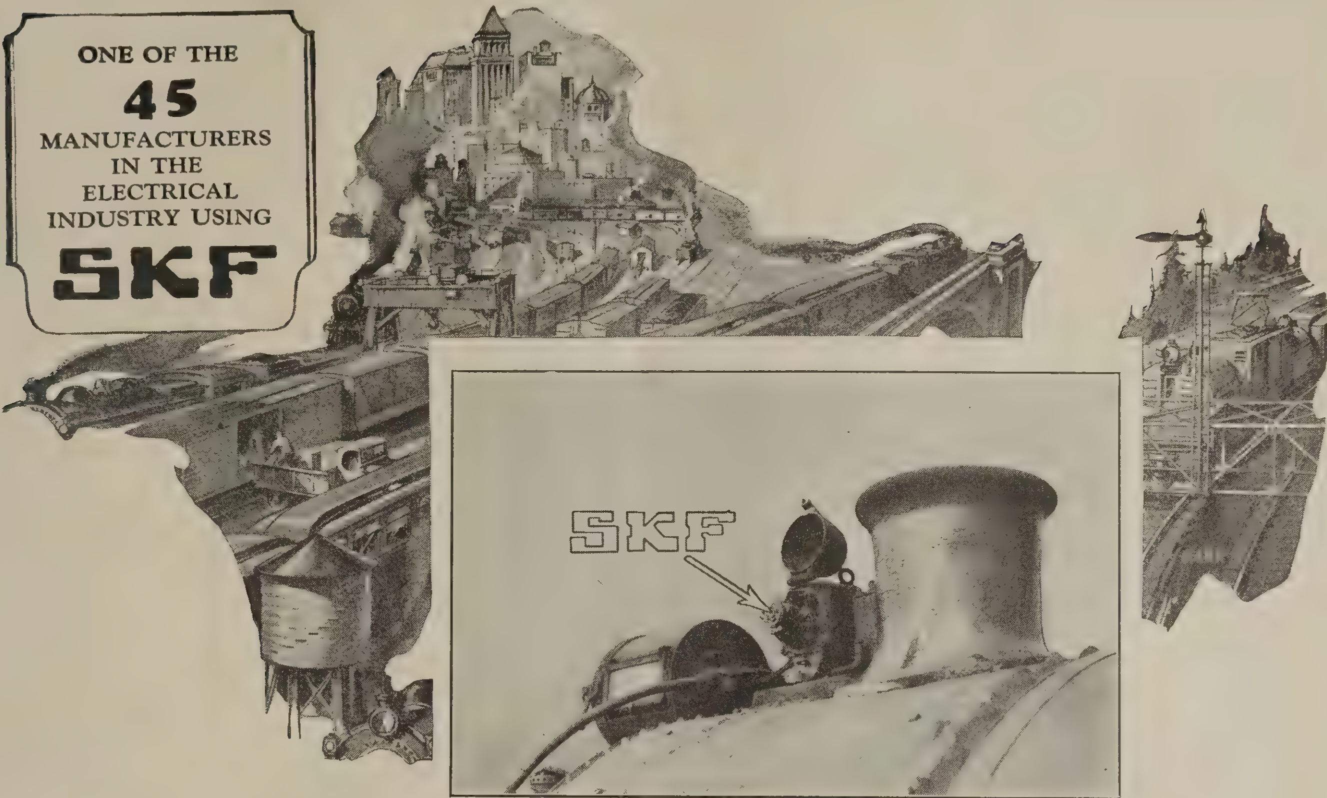
So in Westinghouse construction—and installation—*all* the operating factors are considered at the start. Back of this consideration is a pioneering experience that covers practically every operating condition so far encountered in electrification projects. And out of that experience has been developed the simplest of overhead line systems in operation on most of the notable electrified systems. It is the Westinghouse Inclined Catenary Contact System.

Keeping the "overhead" *down* by keeping it *UP* is a Westinghouse achievement—of engineering, of design, of construction, of application.

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania
Sales Offices in All Principal Cities of the United States and Foreign Countries

Westinghouse
Catenary Line Material

X90192



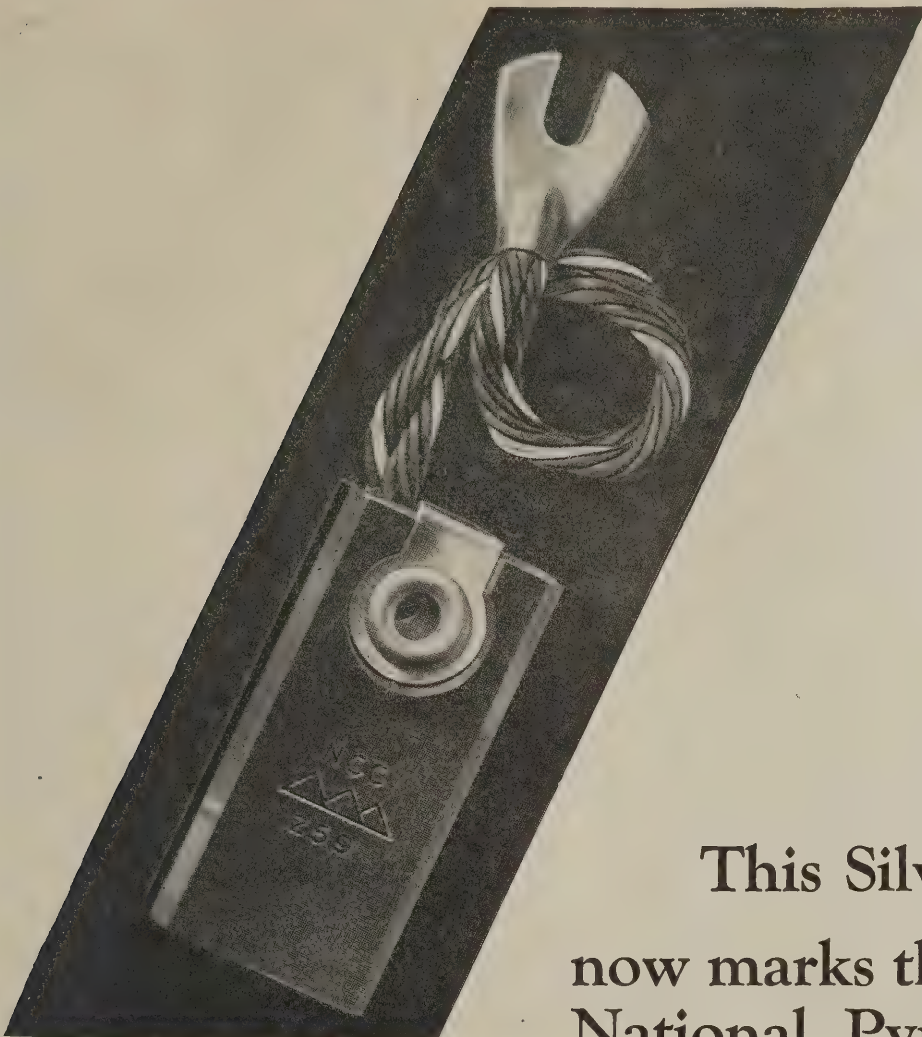
Fair Weather or Foul—Hess-Bright Bearings Keep Generators Going

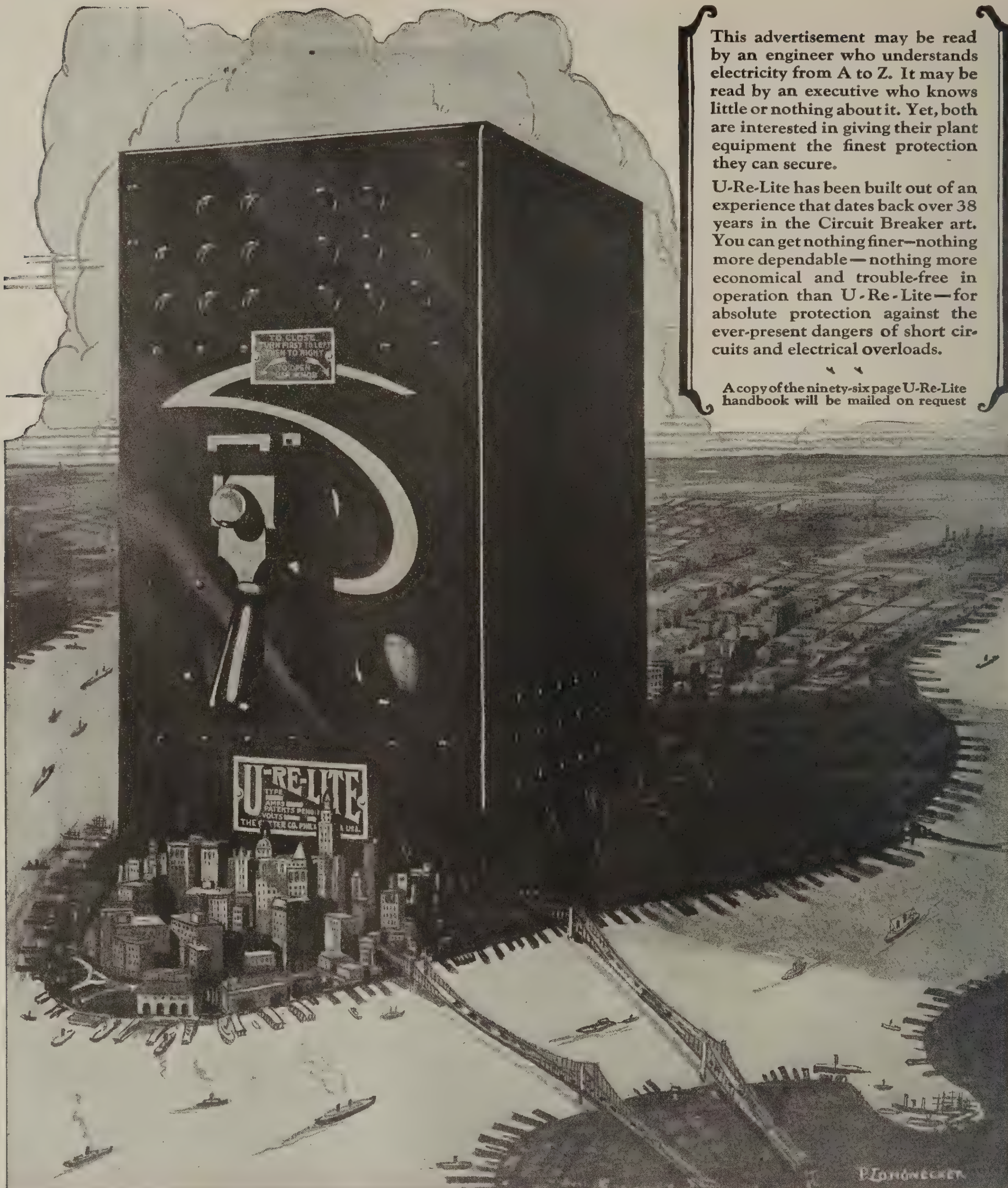
IT'S a pretty hot place for this headlight generator and plenty of dirt; but neither snow, rain nor heat deter it from the job of furnishing juice so that light may penetrate the gloom of night as the iron monster speeds over glistening rails.

Hess-Bright Deep-Groove Ball Bearings, marked SKF, go a long way toward insuring such reliability. They keep armatures permanently in position, prevent stripped buckets, and require no adjustment to compensate for wear.

SKF INDUSTRIES, INCORPORATED
165 Broadway, New York City

1707





This advertisement may be read by an engineer who understands electricity from A to Z. It may be read by an executive who knows little or nothing about it. Yet, both are interested in giving their plant equipment the finest protection they can secure.

U-Re-Lite has been built out of an experience that dates back over 38 years in the Circuit Breaker art. You can get nothing finer—nothing more dependable—nothing more economical and trouble-free in operation than U-Re-Lite—for absolute protection against the ever-present dangers of short circuits and electrical overloads.

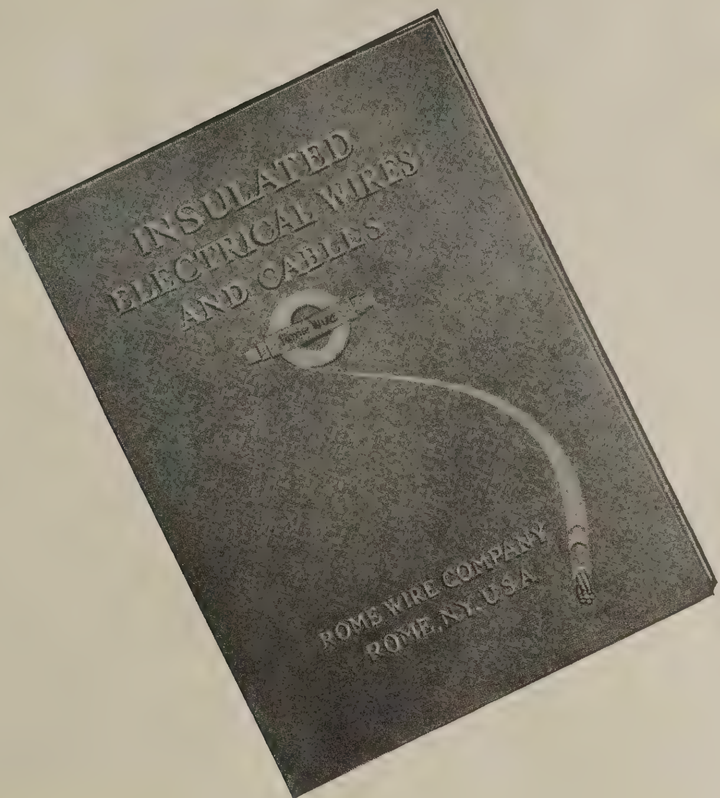
A copy of the ninety-six page U-Re-Lite handbook will be mailed on request

CUTTER

U-RE-LITE I-T-E CIRCUIT BREAKERS

THE CUTTER COMPANY – *Established in 1888* – PHILADELPHIA, PENNSYLVANIA

A new wire catalog for you—



Packed full of tables, charts, and carefully assembled information, this new Rome Insulated Wire and Cable Catalog will be extremely valuable to all wire buyers.

Here is a catalog that has been built, page by page, from the purchaser's point of view. Its tables and charts are not only complete, but conveniently condensed.

Some of the more interesting features include—Chart for Calculating Wiring Circuits; Calculation of Line Currents; Wiring Data for Motors; Conduit Sizes for Wires and Cables; Combined Table of Sizes in Principal Wire Gauges.

If you think such a catalog will help you, fill out the coupon below and return it today. If you would like a copy of our Magnet Wire, or Bare Wire Catalog, note this fact on the coupon as well—Write the number of copies you desire in the little squares.

ROME WIRE COMPANY

Mills and Executive Offices: Rome, N. Y.
Diamond Branch: Buffalo, N. Y.

ROME WIRE

New York
50 Church St.

Detroit
25 Parsons St.

Boston
Little Building

Cleveland
1200 W. 9th St.

Chicago
14 E. Jackson Blvd.

Los Angeles
J. G. Pomeroy Co.
336 Azusa St.

San Francisco
J. G. Pomeroy Co.
960 Folsom St.

Rome Wire Co., Rome, N. Y.

Send me your catalog, "Insulated Electrical Wires and Cables" ☐, Bare Wire Catalog ☐, Magnet Wire Catalog ☐.

Name ....

Firm ....

Street ....

City ....

State ....

2665

Axle Lighting Belts

THIS important piece of equipment need not be a source of expense and aggravation—

Take care to specify Goodrich Axle Lighting Belts and assure longest uninterrupted service.

The success of Goodrich belts in all weathers and climates is best proved by the fact that they are today standard equipment on the country's finest trains.

Made by

Goodrich

Less than 1%

ELECTRICAL engineers on the leading railroads find that failures in service from *all causes* —including *accidents*— over a period of years, average a small fraction of one percent. A remarkable testimonial of Goodrich efficiency.

We cannot make, regardless of price, and have never seen a jar better than Defiance.

The B. F. Goodrich Rubber Co.
Est. 1870 Akron, Ohio

"DEFIANCE"
HARD RUBBER
BATTERY JARS

Classified Advertisements

Rates: Employment Advertisements: Five cents a word and five cents a word for 12 words in address. For Sale Advertisements: $6 an inch, 20 inches to the page. Remittance must accompany each order. Address THE RAILWAY ELECTRICAL ENGINEER, 30 Church Street, New York City.

POSITION WANTED

MAN experienced in all electrical work on steam R. R. and in their shops and power houses and supervision of such work; also expert telephone man. Wishes permanent position. Further particulars and references. Address Box 89, Railway Electrical Engineer, 30 Church Street, New York City.

When you use the columns of the

Railway Electrical Engineer

for your classified advertisements, you may be sure that it reaches the desk of the man you want.

Use the Classified Columns when seeking a new man, a new position, or when buying or selling second-hand equipment.

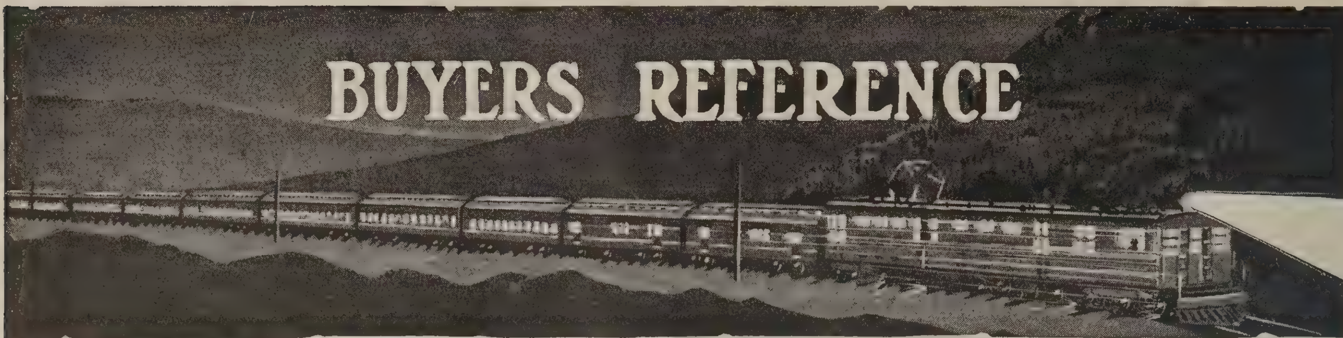
NO GUESS WORK

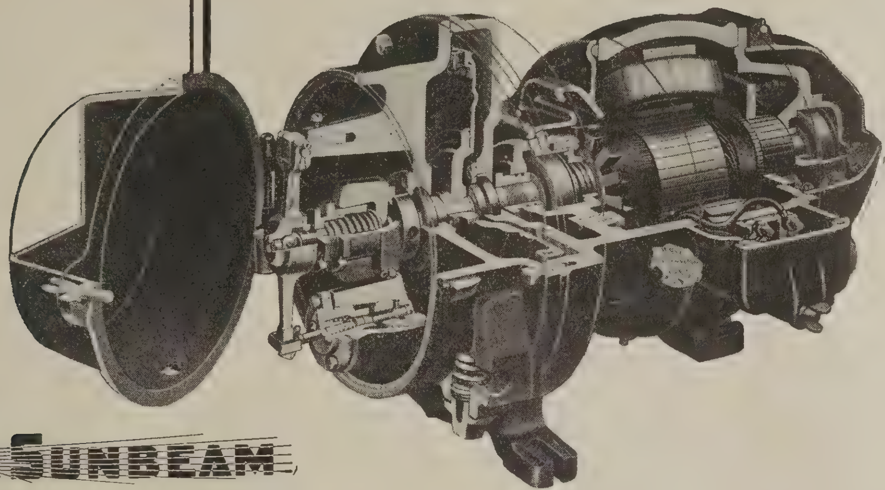
If you were buying a horse and he was just a horse you would have to take for granted the things the owner said, and then wait for experience to show if he had spoken the truth.

But if you bought a horse of blooded stock that had a pedigree, you would not need to take the man's word for it. The pedigree would show his ancestry and race and give you an idea of the animal's capacity for speed and endurance.

It's the same in buying advertising space. Some publications sell "just a horse" and you have to take their circulation statement with a pinch of salt.

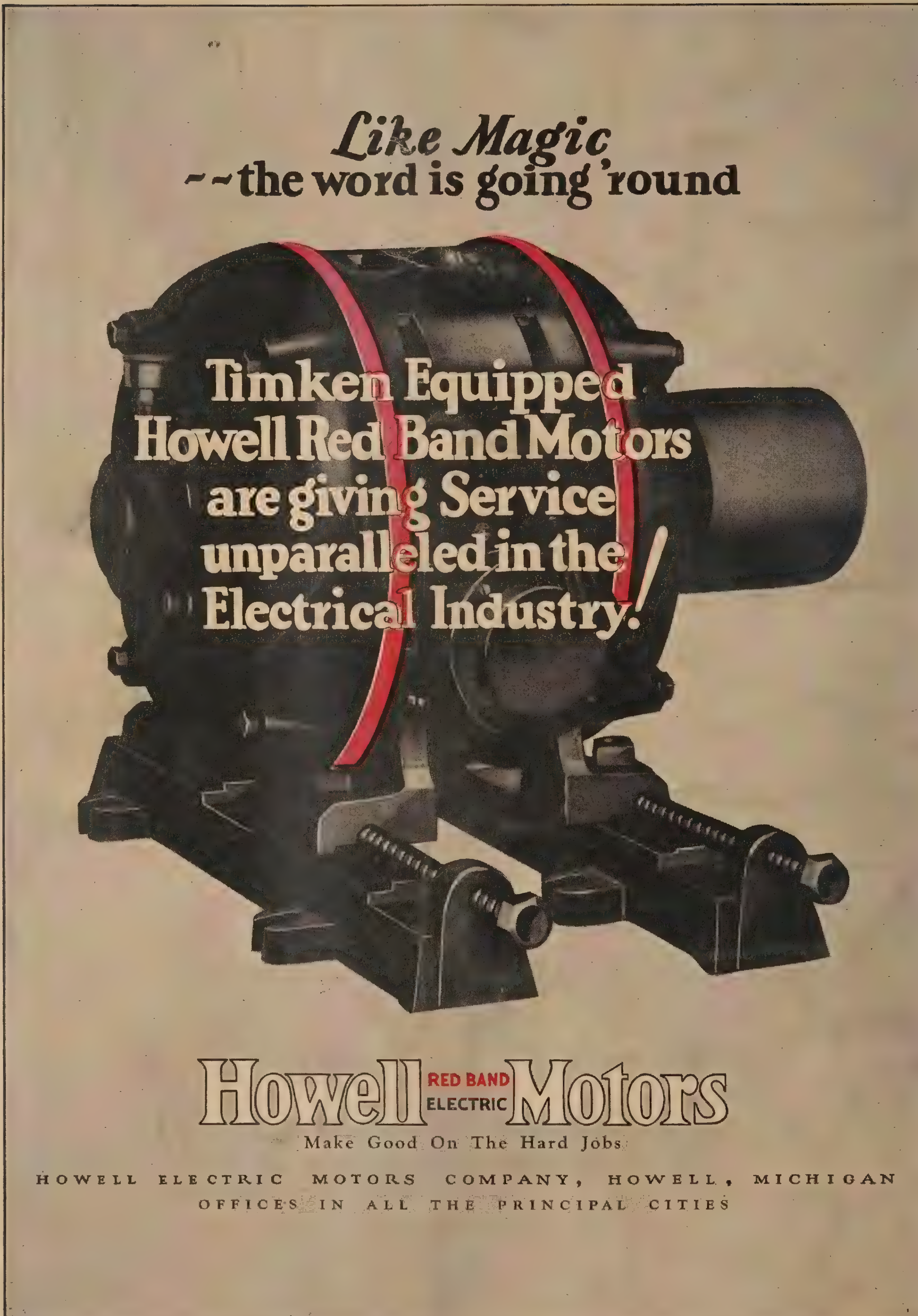
RAILWAY ELECTRICAL ENGINEER is blooded stock. An A. B. C. statement is the pedigree that tells you what to expect in the way of speed and endurance.


BUYERS REFERENCE



BUYERS' REFERENCE

ALPHABETICAL INDEX


Like Magic
--the word is going 'round
Timken Equipped
Howell Red Band Motors
are giving Service
unparalleled in the
Electrical Industry!
Howell RED BAND ELECTRIC Motors
Make Good On The Hard Jobs
HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN
OFFICES IN ALL THE PRINCIPAL CITIES